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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Confederation Line Proximity Study

Proposed Multi-Storey Building
851 Richmond Road - Ottawa

Prepared For

Homestead Land Holdings

October 11, 2017

Report: PG4202-1 Revision 1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Homestead Land Holdings (Homestead) to conduct a Confederation Line proximity study for the proposed multi-storey building to be located at 851 Richmond Road, in the City of Ottawa.

The objective of the current study was to:

- ❑ Review all current information provided by the City of Ottawa with regards to the construction of the Confederation Line.
- ❑ Liason between the City of Ottawa and the Homestead consultant team involved with the aforementioned project.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains a collaboration of civil, structural and geotechnical design information as they pertain to the aforementioned project.

2.0 Development Details

It is understood that the proposed development at 851 Richmond Road will consist of an eleven storey residential building with two levels of underground parking. The development will also include associated access lanes, at grade parking areas and landscaped areas. The proposed underground parking structure for the proposed building is setback 3 m from City of Ottawa Right-of-Way along Richmond Road. The design underside of footing will be between 57 to 58 m (geodetic elevation).

At the time of submission, it is understood that the City of Ottawa proposes that the Confederation Line be constructed in close proximity to the proposed development. Additional details regarding the Confederation Line were not known at the time of submission. It is understood that the design for the Confederation Line will be finalized in 2018. Therefore, several assumptions will be made assuming a 'worst case' scenario regarding the Confederation Line with respect to the proposed development.

- ❑ The Confederation Line alignment will be located below Richmond Road
- ❑ The Confederation Line will be below ground, with the bottom of the tunnel extending approximately 10-12 m below the existing ground surface (55.5 to 53.5 m - geodetic elevation).
- ❑ Based on the subsurface profile at 851 Richmond Road, bedrock is assumed to be at a 5 m depth below the existing ground surface. Therefore, the Confederation Line will be drilled through bedrock.

Paterson was informed by the City of Ottawa that a Confederation Line Proximity Study - Level 2 should be completed for the proposed development. However, due to the undetermined alignment for the Confederation Line adjacent to the subject site, a detailed analysis using actual design details for the Confederation Line is not possible at this time. A Confederation Line Proximity Study - Level 2 study is required where substantial integration and impact on Confederation Line structures and facilities are anticipated. It should be further noted that the proposed building is anticipated to be constructed prior to the construction and operation of the Confederation Line alignment adjacent to the subject site.

The following table lists the applicable requirements for Level 1 and Level 2 study and the response location for each item:

Table 1 - List of Confederation Line Proximity Study Requirements

Level 1 Projects	Response
A site plan of the development with the centreline or reference line of the Confederation Line structure and/or right-of-way located and the relevant distances between the Confederation Line and developer's structure shown clearly;	Presented in Appendix 1
Plan and cross-sections of the development locating the Confederation Line structure/right-of-way and founding elevations relative to the development, including any underground storage tanks and associated piping;	Sheet a300 presented in Appendix 1
A geotechnical investigation report showing up-to-date geotechnical conditions at the site of the development. The geotechnical investigation shall be prepared in accordance with the Geotechnical Investigation and Reporting Guidelines for Development Applications in the City;	Geotechnical Investigation: Paterson Report PG4163-1 Revision 1 dated October 3, 2017 presented in Appendix 2

Structural, foundation, excavation and shoring drawings;	Not available at time of submission. Based on current design details, the proposed building foundation will consist of conventional footings placed directly over a clean, bedrock surface. The 3 m setback for the proposed building foundation from the City of Ottawa right-of-way along Richmond Road provides sufficient separation between the Confederation Line from a geotechnical perspective. No negative impacts are anticipated for the Confederation Line due to the proposed building location.
Acknowledgment that the potential for noise, vibration, electro-magnetic interference and stray current from Confederation Line operations have been considered in the design of the project, and appropriate mitigation measures applied.	Noise and Vibration Study: Paterson Report PG4201-1 dated August 8, 2017 presented in Appendix 3
Level 2 Projects	**Response**
A structural analysis or calculations of the effects of loadings, including construction loading, on the Confederation Line structure, and demonstrating that the Confederation Line will not be adversely affected by the development, including solutions to mitigate any impact on the Confederation Line structure.	No building loads will be imposed on the subject alignment of the Confederation Line due to the presence of sound limestone bedrock at founding level of the proposed building and future construction of the Confederation Line taking place greater than 3 m away from the building foundation through sound bedrock. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Documentation showing that the excavation support system and permanent structure adjacent to the Confederation Line property are designated for at-rest earth pressures.	Temporary shoring system will be designed to at-rest earth pressures as required by the site Geotechnical Report.
Structural drawings, including foundation plans, sections and details, floor plans, column and wall schedules and loads on foundation for the development. The relationship of the development to the Confederation Line structure should be depicted in both plan and section;	No building loads will be imposed on the subject alignment of the Confederation Line due to the presence of sound limestone bedrock at founding level of the proposed building and future construction of the Confederation Line taking place greater than 3 m away from the building foundation through sound bedrock. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.

Shoring design criteria and description of excavation and shoring method;	Temporary shoring system will consist of soldier piling and lagging. However, the proposed building construction will be completed prior to the construction of the subject alignment of the Confederation Line. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Groundwater control plan, including the determination of the short-term (during construction) and long-term effects of dewatering on the Confederation Line structure, and provision of assurances that the influences of dewatering will have no impact on the Confederation Line structure;	Confederation Line is located below the proposed development. No groundwater lowering effects due to the proposed development are anticipated. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Proposal to replace/repair waterproofing system of the affected Confederation Line structure, including the Confederation Line expansion joint;	Not applicable - building construction will be completed prior to construction of the subject alignment of the Confederation Line. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Identification of utility installations proposed through or adjacent to Confederation Line property.	Not applicable - building construction will be completed prior to construction of the subject alignment of the Confederation Line. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Identification of the exhaust air quality and relationship of air in-take/discharge to the Confederation Line at-grade vent shaft openings and station entrance openings.	Not applicable - building construction will be completed prior to construction of the subject alignment of the Confederation Line. Refer to Proximity Assessment Report PG4202-LET.01 Revision 1 dated October 11, 2017 presented in Appendix 4.
Proposal for a pre-construction condition survey of the Confederation Line structure, including a survey to confirm locations of existing walls and foundations;	Not applicable - building construction will be completed prior to construction of the subject alignment of the Confederation Line.
Monitoring plan for movement of the shoring and Confederation Line structure prior to and during construction of the development, including an Action Protocol.	Not applicable - building construction will be completed prior to construction of the subject alignment of the Confederation Line.

We trust that this information satisfies your immediate request.

Paterson Group Inc.

Stephanie A. Boisvenue, P.Eng.

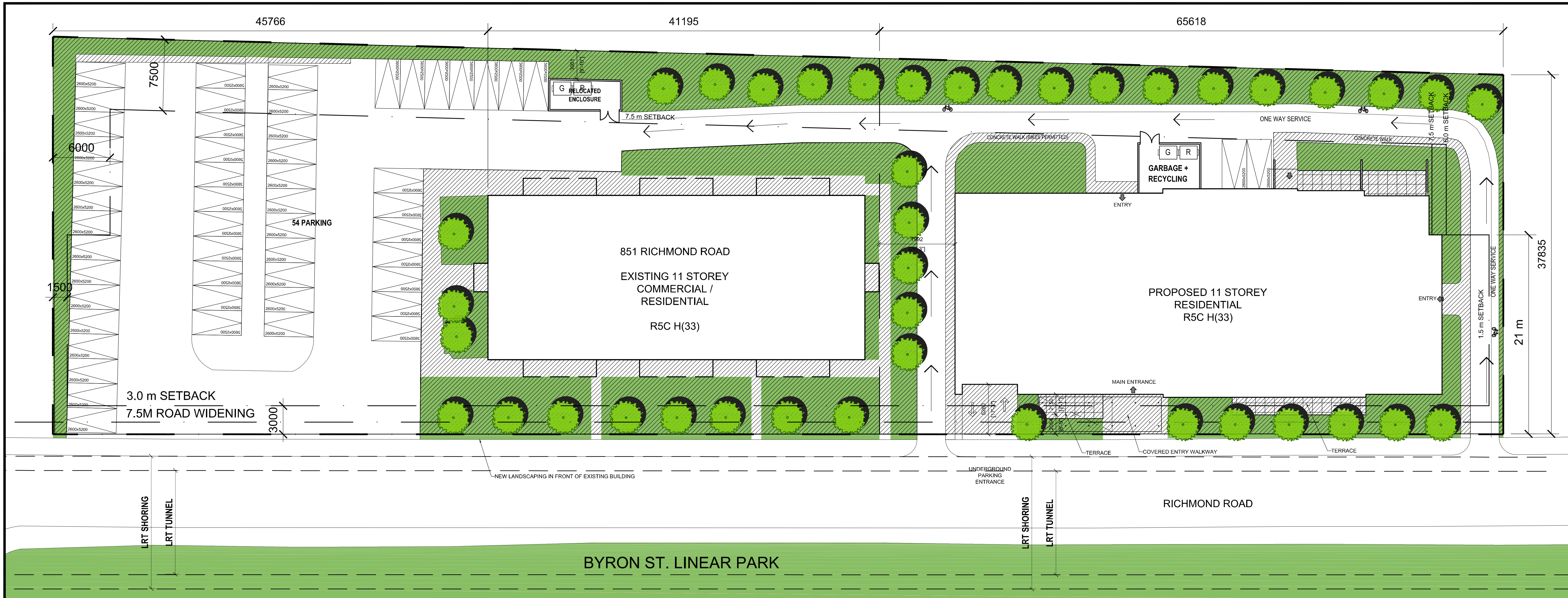
David J. Gilbert, P.Eng.

APPENDIX 1

Site Plan

Sheet a300 - Transverse Building Section and LRT

Topographic Survey Plan



BUILDING INFORMATION

OPEN SPACE
FULL SITE AREA: 65,474 sf
OPEN SPACE:

TOTAL 21,906 sf **33.5%**

NEW PROPOSED BUILDING SITE AREA: 27,351 sf
OPEN SPACE:

TOTAL 10,352 sf **37.85%**

OPEN SPACE

OPEN GREEN SPACE

BLDG FOOTPRINT (LOT COVERAGE)
BOTH NEW/EXISTING: 19,172 sf
NEW PROPOSED BUILDING: 11,692 sf

UNIT TOTALS
GROUND FLOOR : (2 UNITS, 3.5 m height)
1 BEDROOM 1
2 BEDROOM 1

LEVELS 2 - 11: 13 UNITS per floor (130) 2.9 m height
1 BEDROOM 7
2 BEDROOM 6
TOTAL: 132 UNITS

CONSTRUCTION AREA
LEVEL 1 11,693 sf
LEVELS 2 -11 12,265 sf per floor (122,650)
TOTAL: 134,343 sf

BLDG PARKING TOTALS
LEVEL P2: 67
LEVEL P1: 63
TOTAL: 130

STORAGE SPACE & BIKE TOTALS
3x6 STORAGE LOCKERS (CAN BE USED FOR BIKES): 90
3X4 STORAGE LOCKERS: 66
BIKE PARKING (ground floor): 38
TOTAL BIKE STG CAPACITY: 128
TOTAL STORAGE LOCKERS: 156

AMENITY SPACE
AMENITY SMALL (MAIN FLR): 854sf
AMENITY LARGE (MAIN FLR): 2,504sf
AMENITY BALCONIES: (COMBINED LEVELS 2-11) 10,828sf
AMENITY ROOF: (INCL. VEST.) 8342sf
TOTAL: 14,186sf

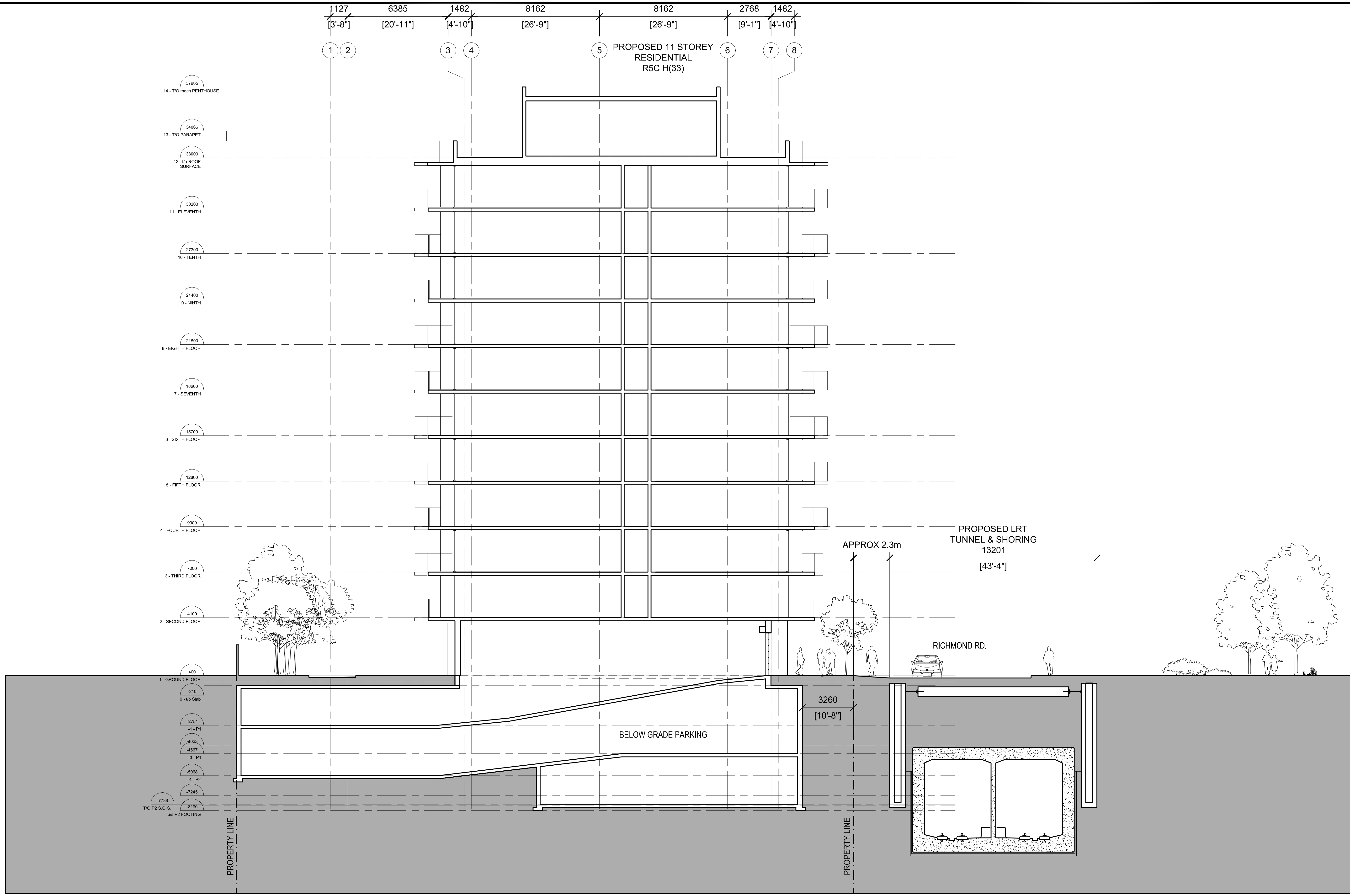
0m 5 10 15

rla/architecture

SITE PLAN
SCALE 1:400
date: Friday, September 29, 2017

851 RICHMOND ROAD
OTTAWA ONTARIO

SHEET #
A100
PROJ. # 1705



RODERICKLAHEY ARCHITECT INC

TRANSVERSE BUILDING SECTION & LRT

SCALE TO FIT date:August 11, 2017

851 RICHMOND ROAD
OTTAWA ONTARIO

SHEET #
a300

PROJ. # 1705

TOPOGRAPHICAL PLAN OF SURVEY OF

PART OF LOT 26
CONCESSION 1 (OTTAWA FRONT)
Geographic Township of Nepean
CITY OF OTTAWA

Prepared by Annis, O'Sullivan, Vollebekk Ltd.

Scale 1 : 200

8.0 6.0 4.0 2.0 0 4 8 Metres

Metric

DISTANCES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048

Surveyor's Certificate

I CERTIFY THAT :

1. This survey and plan are correct and in accordance with the Surveys Act, the Surveyors Act and the Land Titles Act and the regulations made under them.
2. The survey was completed on the 24th day of March, 2017.

April 11/2017 (signature)

Date

Edward M. Lancaster
Ontario Land Surveyor

Notes & Legend

	Denotes	
—□—	"	Survey Monument Planted
—■—	"	Survey Monument Found
SIB	"	Standard Iron Bar
SSIB	"	Short Standard Iron Bar
IB	"	Iron Bar
CC	"	Cut Cross
(WIT)	"	Witness
Meas.	"	Measured
(AOG)	"	Annis, O'Sullivan, Vollebekk Ltd.
(P1)	"	(1692) Plan Dated July 31, 1998
(P2)	"	Registered Plan 4M-1097
(P3)	"	(AOG) Plan dated February 8, 2016
(P4)	"	(AOG) Plan dated February 16, 1973
(D)	"	Inst. No. N621870
	"	Deciduous Tree
	"	Coniferous Tree
FH	"	Fire Hydrant
WV	"	Water Valve
MH-S	"	Maintenance Hole (Sanitary)
CB	"	Catch Basin
GM	"	Gas Meter
B	"	Bollard
S	"	Sign
PO-M	"	Metal Pole
LS	"	Light Standard
AC	"	Air Conditioner
Ø	"	Diameter
+ 65.00	"	Location of Elevations
+ 65.00	"	Top of Concrete Curb Elevation
+ 65.00*	"	Top of Retaining Wall Elevation
C/L	"	Centreline
CRW	"	Concrete Retaining Wall
BRW	"	Boulder Retaining Wall
———	"	Property Line

Bearings are grid bearings, derived from the Westerly limit of Richmond Road, shown to be N 36° 14' 30" E on Plan (AOG) dated February 8, 2016 and are referred tothe Central Meridian of MTM Zone 9 (76°30' West Longitude) NAD-83 (original).

SITE AREA = 6061.8 m²

Topographic data was collected under Winter Conditions. Snow cover and ice preclude determining location and elevation of some topographical data that is otherwise visible.

ELEVATION NOTES

1. Elevations shown are geodetic and are referred to the CGVD28 geodetic datum.
2. It is the responsibility of the user of this information to verify that the job benchmark has not been altered or disturbed and that it's relative elevation and description agrees with the information shown on this drawing.

UTILITY NOTES

1. This drawing cannot be accepted as acknowledging all of the utilities and it will be the responsibility of the user to contact the respective utility authorities for confirmation.
2. Only visible surface utilities were located.
3. A field location of underground plant by the pertinent utility authority is mandatory before any work involving breaking ground, probing, excavating etc.

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Job No. 19552-17 PT LT 26 C I OF T-D DI | A.M.

APPENDIX 2

Geotechnical Investigation:

Report PG4163-1 Revision 1 dated October 3, 2017

Geotechnical Engineering

Environmental Engineering

Hydrogeology

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Geotechnical Investigation

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Homestead Land Holdings Ltd. (Homestead) to conduct a geotechnical investigation for the proposed multi-storey building to be located at 851 Richmond Road in the City of Ottawa (refer to Figure 1 - Key Plan presented in Appendix 2).

The objective of the investigation was to:

❑ Determine the subsoil and groundwater conditions at this site by means of boreholes.

❑ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of this present investigation. A report addressing environmental issues for the subject site was prepared under separate cover.

2.0 Proposed Project

It is our understanding that the proposed project consists of a multi-storey building with two underground parking levels encompassing the majority of the subject site.

3.0 Method of Investigation

3.1 Field Investigation

The field program for our geotechnical investigation was carried out on June 1, 2017. At that time, a total of six (6) boreholes were advanced to a maximum depth of 7.0 m. The borehole locations were determined in the field by Paterson personnel taking into consideration site features and underground services. The locations of the boreholes are shown on Drawing PG4163-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer. The testing procedure consisted of augering and rock coring to the required depths and at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using two different techniques, namely, sampled directly from the auger flights (AU) or collected using a 50 mm diameter split-spoon (SS) sampler. Rock cores (RC) were obtained using 47.6 mm inside diameter coring equipment. All samples were visually inspected and initially classified on site. The auger and split-spoon samples were placed in sealed plastic bags, and rock cores were placed in cardboard boxes. All samples were transported to our laboratory for further examination and classification. The depths at which the auger, split spoon and rock core samples were recovered from the boreholes are shown as AU, SS and RC, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

The recovery value and a Rock Quality Designation (RQD) value were calculated for each drilled section of bedrock and are presented on the borehole logs. The recovery value is the length of the bedrock sample recovered over the length of the drilled section. The RQD value is the total length of intact rock pieces longer than 100 mm over the length of the core run. The values indicate the bedrock quality.

The subsurface conditions observed in the boreholes were recorded in detail in the field. The soil profiles are presented on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Monitoring wells and flexible standpipes were installed in the boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The borehole locations were determined by Paterson personnel taking into consideration the presence of underground and aboveground services. The location and ground surface elevation at each borehole location was surveyed by Paterson personnel. The ground surface elevation at the borehole locations were surveyed with respect to a temporary benchmark (TBM), consisting of the top of catch basin located within the northeast corner the existing site. A geodetic elevation of 65.24 m was provided for the TBM by Homestead. The borehole locations and ground surface elevation at each borehole location are presented on Drawing PG4163-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples and rock cores recovered from the subject site were examined in our laboratory to review the results of the field logging.

4.0 Observations

4.1 Surface Conditions

The subject site is currently occupied by at-grade parking for the adjacent multi-storey residential building to the west. The site is bordered to the north by an easement, which contains a large diameter watermain, followed by residential buildings, to the south by Richmond Road and to the east by at grade parking area. The ground surface across the site is relatively flat and at grade with the neighbouring properties.

4.2 Subsurface Profile

Generally, the subsurface profile encountered at the borehole locations consists of 60 to 100 mm thickness of asphalt overlying a granular layer, consisting of crushed stone with silt and sand with maximum thickness of 230 mm. The pavement structure lies atop a fill layer, consisting of loose to compact, brown to grey sand and gravel with trace to some silt and clay which extends to a depth of approximately 1.5 to 2.5 m. A native glacial till deposit was encountered underlying the abovenoted fill layers followed by a grey limestone bedrock. Generally, the bedrock quality consists of poor quality within the upper 0.5 to 1 m and fair to excellent quality at depth based on the RQD values. The upper portion of the bedrock was noted to consist of a weathered, poor quality bedrock. Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for specific details of the soil profiles encountered at each test hole location.

Based on available geological mapping, the bedrock in this area mostly consists of limestone with some shaly partings of the Ottawa formation with an overburden drift thickness of less than 5 m depth.

4.3 Groundwater

The measured groundwater levels in the monitoring wells and piezometers at the borehole locations are presented in Table 1. It should be further noted that the groundwater level could vary at the time of construction.

Table 1 - Summary of Groundwater Level Readings				
Test Hole Number	**Ground Elevation (m)**	**Groundwater Levels (m)**		**Recording Date**
		Depth	**Elevation**	
BH 1	66.03	2.93	63.10	June 8, 2017
BH 2	65.69	2.31	63.38	June 8, 2017
BH 3	65.44	3.72	61.72	June 8, 2017
BH 4	66.05	2.19	63.86	June 8, 2017
BH 5	65.79	3.20	62.59	June 8, 2017
BH 6	65.56	3.35	62.21	June 8, 2017

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is adequate for the proposed multi-storey building. The proposed building is expected to be founded on conventional footings placed on clean, surface sounded bedrock.

Bedrock removal will be required to complete the two (2) levels of underground parking. Line drilling and controlled blasting where large quantities of bedrock need to be removed is recommended. The blasting operations should be planned and completed under the guidance of a professional engineer with experience in blasting operations.

An alignment of a large diameter watermain runs within an easement along the north property boundary of the subject site. It is expected that the adjacent watermain could be subjected to potential vibrations associated with the bedrock blasting program. To ensure that no detrimental vibrations cause damage to the adjacent watermain, a vibration attenuation trench is recommended for the bedrock along the north excavation face, as well as a vibration monitoring and control program during the blasting and excavation work required for the proposed building excavation.

The above and other considerations are further discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Due to the relatively shallow bedrock depth at the subject site and the anticipated founding level for the proposed building, all existing overburden material will be excavated from within the proposed building footprint. Bedrock removal will be required for the construction of the parking garage levels.

Bedrock Removal

Based on the bedrock encountered in the area, it is expected that line-drilling in conjunction with hoe-ramming or controlled blasting will be required to remove the bedrock. In areas of weathered bedrock and where only a small quantity of bedrock is to be removed, bedrock removal may be possible by hoe-ramming.

Prior to considering blasting operations, the effects on the existing services, buildings and other structures should be addressed. A pre-blast or construction survey located in proximity of the blasting operations should be conducted prior to commencing construction. The extent of the survey should be determined by the blasting consultant and sufficient to respond to any inquiries/claims related to the blasting operations.

As a general guideline, peak particle velocity (measured at the structures) should not exceed 25 mm/s during the blasting program to reduce the risks of damage to the existing structures.

The blasting operations should be planned and conducted under the supervision of a licensed professional engineer who is an experienced blasting consultant.

Excavation side slopes in sound bedrock could be completed with almost vertical side walls. Where bedrock is of lower quality, the excavation face should be free of any loose rock. An area specific review should be completed by the geotechnical consultant at the time of construction to determine if rock bolting or other remedial measures are required to provide a safe excavation face for areas where low quality bedrock is encountered.

A vibration attenuation trench is recommended to be completed within the bedrock along the north property boundary. The construction of the vibration attenuation trench would require line drilling in a tight pattern on both sides of the proposed 1 m wide trench alignment and within the interior portion of the trench to the design underside of footing elevation. A hoe ram operation would be used to break up the bedrock and remove it from the trench. It is expected that the coreholes for the bedrock blasting program may not be possible within 1 to 2 m of the attenuation trench due to the presence of the drilled holes within the attenuation trench, which can cause an energy loss and blow-out during blasting if connected to the blast source by potential fractures within the bedrock. Therefore, a hoe ramming operation will most likely be required to complete the bedrock removal within the area adjacent to the attenuation trench.

Vibration Considerations

Construction operations could cause vibrations, and possibly, sources of nuisance to the community. Therefore, means to reduce the vibration levels as much as possible should be incorporated in the construction operations to maintain a cooperative environment with the residents.

The following construction equipments could cause vibrations: piling equipment, hoe ram, compactor, dozer, crane, truck traffic, etc. The construction of the shoring system with soldier piles or sheet piling will require these pieces of equipments. Vibrations, caused by blasting or construction operations could cause detrimental vibrations on the adjoining buildings and structures. Therefore, it is recommended that all vibrations be limited.

Two parameters determine the recommended vibration limit, the maximum peak particle velocity and the frequency. For low frequency vibrations, the maximum allowable peak particle velocity is less than that for high frequency vibrations. As a guideline, the peak particle velocity should be less than 15 mm/s between frequencies of 4 to 12 Hz, and 50 mm/s above a frequency of 40 Hz (interpolate between 12 and 40 Hz). These guidelines are for current construction standards. These guidelines are above perceptible human level and, in some cases, could be very disturbing to some people, a pre-construction survey is recommended to minimize the risks of claims during or following the construction of the proposed building.

Vibration Monitoring and Control Plan

To ensure that no disturbance to the existing watermain occurs, a vibration monitoring and control plan (VMCP) is recommended during the excavation program. The purpose of the vibration monitoring and control plan is to provide measures to be implemented by the contractor to manage excavation operations and any other vibration sources during the construction for the proposed development. The VMCP will also provide a guideline for assessing results against the relevant vibration impact assessment criteria and recommendations to meet the required limits.

The monitoring program will incorporate real time results at the existing watermain segment adjacent to the subject site. The monitoring equipment should consist of a tri-axial seismograph, capable of measuring vibration intensities up to 254 mm/s at a frequency response of 2 to 250 Hz. At least two vibration monitoring devices should be placed adjacent to the existing watermain. It is recommended that the vibration monitoring devices be installed at invert level of the existing watermain and periodically inspected during the construction program.

A copy of the geotechnical report, which includes the VMCP should be provided to all parties involved with the construction for review. A meeting between Paterson and site contractor should be conducted prior to any excavation or construction of the subject site to review the following:

- ❑ Review the pre-condition/pre-construction survey;
- ❑ Control measures (i.e vibrations, noise);
- ❑ Monitoring locations;
- ❑ Tracking and reporting of excavation progress, and;
- ❑ Review procedure for exceedances (i.e vibrations, noise), complaints, evaluation and corrective measures.

When an event is triggered, Paterson will review the results and provide any necessary feedback. Otherwise, the vibration results will be summarized in the weekly report. The following table outlines the vibration limits for the adjacent watermain segment.

Table 2 - Structure Vibration Limits for adjacent Watermain Segment

Dominant Frequency Range (Hz)	Peak Particle Velocity (mm/s)	Event	Description of Event
<10	all	none	no action required
<40	>10	trigger level	Warning e-mail sent to contractor.
<40	≥15	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.
>40	>15	trigger level	Warning e-mail sent to contractor.
>40	≥20	exceedance level	Exceedance e-mail and phone call to the contractor. All operations are ceased to review on-site activities.

The monitoring protocol should include the following information:

Trigger Level Event

- Paterson will review all vibrations over the established warning level, and;
- Paterson will notify the contractor if any vibration occur due to construction activities and are close to exceedance level.

Exceedance Level Event

- Paterson will notify all the relevant stakeholders via email;
- Ensure monitors are functioning, and;
- Issue the vibration exceedance result.

Fill Placement

Fill used for grading beneath the building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the proposed building areas should be compacted to at least 98% of its standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

5.3 Foundation Design

Bearing Resistance Values

Footings placed on a clean, surface sounded limestone bedrock surface can be designed using a factored bearing resistance value at ultimate limit states (ULS) of **2,500 kPa** incorporating a geotechnical resistance factor of 0.5.

A clean, surface-sounded bedrock bearing surface should be free of loose materials, and have no near surface seams, voids, fissures or open joints which can be detected from surface sounding with a rock hammer.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a sound bedrock bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1H:6V (or flatter) passes only through sound bedrock or a material of the same or higher capacity as the bedrock, such as concrete. A weathered bedrock bearing medium will require a lateral support zone of 1H:1V (or flatter).

Settlement

Footings bearing on an acceptable bedrock bearing surface and designed for the bearing resistance values provided herein will be subjected to negligible potential post-construction total and differential settlements.

5.4 Design for Earthquakes

A site specific shear wave velocity test was completed by Paterson to accurately determine the applicable seismic site classification for foundation design of the proposed building as presented in Table 4.1.8.4.A of the Ontario Building Code 2012. Two (2) shear wave velocity profiles from our on-site testing are presented in Appendix 2.

Field Program

The location of the seismic array was chosen to provide adequate coverage of the area. The seismic array testing location is presented in Drawing PG4163-1 - Test Hole Location Plan in Appendix 2.

At the seismic array location, Paterson field personnel placed 18 horizontal 4.5 Hz. geophones mounted to the surface by means of two 75 mm ground spikes attached to the geophone land case. The geophones were spaced at 2 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was connected to a computer laptop and a hammer trigger switch attached to a 12 pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between five to ten times at each shot location to improve signal to noise ratio. The shot locations are also completed in forward and reverse directions (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot locations are located at 3,4.5 and 13.5 m away from the first, 3, 4.5, and 14 m away from the last geophone, and at the center of the seismic array.

The methods of testing completed by Paterson are guided by the standard testing procedures used by the expert seismologists at Carleton University and Geological Survey of Canada (GSC).

Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves. The interpretation is repeated at each shot location to provide an average shear wave velocity, Vs_{30}, of the upper 30 m profile, immediately below the building's foundation.

Based on the test results, the average overburden seismic shear wave velocity is 248 m/s. Through interpretation, the bedrock has a shear wave velocity of 2,256 m/s. The Vs_{30} was calculated using the standard equation for average shear wave velocity from the Ontario Building Code (OBC) 2012.

The Vs_{30} was calculated using the standard equation for average shear wave velocity calculation from the Ontario Building Code (OBC) 2012, as presented below.

$$V_{s30} = \frac{Depth_{OfInterest}(m)}{\sum\left(\frac{(Depth_i(m)}{Vs_i(m/s)}\right)}$$

$$V_{s30} = \frac{30m}{\left(\frac{0.0m}{248m/s} + \frac{30.0m}{2{,}256m/s}\right)}$$

$$V_{s30} = 2{,}256m/s$$

Based on the results of the seismic testing, the average shear wave velocity, Vs_{30}, beneath the foundation is 2,256 m/s. Therefore, a **Site Class A** is applicable for design of the proposed buildings, as per Table 4.1.8.4.A of the OBC 2012. The soils underlying the subject site are not susceptible to liquefaction.

5.5 Basement Slab

All overburden soil will be removed for the proposed building and the basement floor slab will be founded on a bedrock medium. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consists of a 19 mm clear crushed stone.

In consideration of the groundwater conditions encountered during the investigation, a subfloor drainage system, consisting of lines of perforated drainage pipe subdrains connected to a positive outlet, should be provided in the clear stone backfill under the lower basement floor.

5.6 Basement Wall

It is expected that a portion of the basement walls are to be poured against a composite drainage blanket, which will be placed against the exposed bedrock face. A nominal coefficient of at-rest earth pressure of 0.05 is recommended in conjunction with a dry unit weight of 23.5 kN/m^3 (effective unit weight of 15.5 kN/m^3). A seismic earth pressure component will not be applicable for the foundation wall, which is to be poured against the bedrock face. It is expected that the seismic earth pressure will be transferred to the underground floor slabs, which should be designed to accommodate these pressures. A hydrostatic groundwater pressure should be added for the portion below the groundwater level.

Undrained conditions are anticipated (i.e. below the groundwater level). Therefore, the applicable effective unit weight of the retained soil should be 13 kN/m^3, where applicable. A hydrostatic pressure should be added to the total static earth pressure when calculating the effective unit weight.

Two distinct conditions, static and seismic, should be reviewed for design calculations. The parameters for design calculations for the two conditions are presented below.

Static Conditions

The static horizontal earth pressure (p_o) could be calculated with a triangular earth pressure distribution equal to $K_o \cdot \gamma \cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil, 0.5
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)

An additional pressure with a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Conditions

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) could be calculated using $0.375 \cdot a_c \cdot \gamma \cdot H^2/g$ where:

a_c = $(1.45 - a_{max}/g)a_{max}$
γ = unit weight of fill of the applicable retained soil (kN/m^3)
H = height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. The vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions could be calculated using $P_o = 0.5\ K_o\ \gamma\ H^2$, where $K_o = 0.5$ for the soil conditions presented above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\} / P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

5.7 Pavement Structure

For design purposes, the pavement structure presented in the following tables could be used for the design of car parking areas and access lanes.

Table 3 - Recommended Pavement Structure - Car Only Parking Areas

Thickness (mm)	Material Description
50	**Wear Course** - HL 3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
300	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Table 4 - Recommended Pavement Structure - Access Lanes	
Thickness (mm)	**Material Description**
40	**Wear Course -** HL3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course -** HL8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
400	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, in situ soil or OPSS Granular B Type I or II material placed over in situ soil or fill	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated to a competent layer and replaced with OPSS Granular B Type II material. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, such as Terratrack 200 or equivalent, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment, noting that excessive compaction can result in subgrade softening.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed structures. It is expected that insufficient room is available for exterior backfill. It is suggested that this system could be as follows:

- ❏ Bedrock vertical surface (Hoe ram any irregularities and prepare bedrock surface. Shotcrete areas to fill in cavities and smooth out angular features at the bedrock surface);
- ❏ composite drainage layer

It is recommended that the composite drainage system (such as Miradrain G100N, Delta Drain 6000 or equivalent) extend down to the footing level. It is recommended that 150 mm diameter sleeves at 3 m centres be cast in the footing or at the foundation wall/footing interface to allow the infiltration of water to flow to the interior perimeter drainage pipe. The perimeter drainage pipe and underfloor drainage system should direct water to sump pit(s) within the lower basement area.

Underfloor Drainage

It is anticipated that underfloor drainage will be required to control water infiltration. For preliminary design purposes, we recommend that 100 or 150 mm in perforated pipes be placed at 6 m centres. The spacing of the underfloor drainage system should be confirmed at the time of completing the excavation when water infiltration can be better assessed.

Foundation Backfill

Above the bedrock surface, backfill against the exterior sides of the foundation walls should consist of free-draining non frost susceptible granular materials. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a drainage geocomposite, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum 1.5 m thick soil cover (or equivalent) should be provided in this regard.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

Unsupported Excavations

The side slopes of excavations in the soil and fill overburden materials should be either cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be undertaken by open-cut methods (i.e. unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below groundwater level. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

Temporary Shoring

The design and approval of the shoring system will be the responsibility of the shoring contractor and the shoring designer hired by the shoring contractor. It is the responsibility of the shoring contractor to ensure that the temporary shoring is in compliance with safety requirements, designed to avoid any damage to adjacent structures and include dewatering control measures. In the event that subsurface conditions differ from the approved design during the actual installation, it is the responsibility of the shoring contractor to commission the required experts to re-assess the design and implement the required changes. Furthermore, the design of the temporary shoring system should take into consideration, a full hydrostatic condition which can occur during significant precipitation events.

The temporary system could consist of soldier pile and lagging system or interlocking steel sheet piling. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be included to the earth pressures described below. These systems could be cantilevered, anchored or braced. Generally, the shoring systems should be provided with tie-back rock anchors to ensure the stability. The shoring system is recommended to be adequately supported to resist toe failure, if required, by means of rock bolts or extending the piles into the bedrock through pre-augered holes if a soldier pile and lagging system is the preferred method.
The earth pressures acting on the shoring system may be calculated with the following parameters.

Table 5 - Soil Parameters

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Dry Unit Weight (γ), kN/m^3	20
Effective Unit Weight (γ), kN/m^3	13

The active earth pressure should be calculated where wall movements are permissible while the at-rest pressure should be calculated if no movement is permissible. The dry unit weight should be calculated above the groundwater level while the effective unit weight should be calculated below the groundwater level.

The hydrostatic groundwater pressure should be included to the earth pressure distribution wherever the effective unit weight are calculated for earth pressures. If the groundwater level is lowered, the dry unit weight for the soil/bedrock should be calculated full weight, with no hydrostatic groundwater pressure component.

For design purposes, the minimum factor of safety of 1.5 should be calculated.

6.4 Pipe Bedding and Backfill

A minimum of 300 mm of OPSS Granular A should be placed for bedding for sewer or water pipes when placed on bedrock subgrade. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to a minimum of 300 mm above the pipe obvert should consist of OPSS Granular A (concrete or PSM PVC pipes) or sand (concrete pipe). The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to a minimum of 95% of the SPMDD.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to reduce the potential differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD.

6.5 Groundwater Control

Groundwater Control for Building Construction

The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Infiltration levels are anticipated to be low through the excavation face. The groundwater infiltration will be controllable with open sumps and pumps.

A temporary MOE permit to take water (PTTW) will be required for this project if more than 50,000 L/day are to be pumped during the construction phase. A minimum of four to five months should be allocated for completion of the application and issuance of the permit by the MOE.

Long-term Groundwater Control

Our recommendations for the proposed building's long-term groundwater control are presented in Subsection 6.1. Any groundwater encountered along the building's perimeter or sub-slab drainage system will be directed to the proposed building's cistern/sump pit. Provided the proposed groundwater infiltration control system is properly implemented and approved by the geotechnical consultant at the time of construction, it is expected that groundwater flow will be low (i.e.- less than 50,000 L/day) with peak periods noted after rain events. A more accurate estimate can be provided at the time of construction, once groundwater infiltration levels are observed. It is anticipated that the groundwater flow will be controllable using conventional open sumps.

Impacts on Neighbouring Structures

Based on our observations, a local groundwater lowering is anticipated under short-term conditions due to construction of the proposed building. It should be noted that the extent of any significant groundwater lowering will take place within a limited range of the subject site due to the minimal temporary groundwater lowering.

The neighbouring structures are expected to be founded within native glacial till and/or directly over a bedrock bearing surface. No issues are expected with respect to groundwater lowering that would cause long term damage to adjacent structures surrounding the proposed building.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

Where excavations are completed in proximity of existing structures which may be adversely affected due to the freezing conditions. In particular, where a shoring system is constructed, the soil behind the shoring system will be subjected to freezing conditions and could result in heaving of the structure(s) placed within or above frozen soil. Provisions should be made in the contract document to protect the walls of the excavations from freezing, if applicable.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the installation of straw, propane heaters and tarpaulins or other suitable means. The base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations and pavement construction are difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be considered if such activities are to be completed during freezing conditions. Additional information could be provided, if required.

6.7 Corrosion Potential and Sulphate

The results of the analytical testing show that the sulphate content is less than 0.1%. This result indicates that Type 10 Portland cement (normal cement) would be appropriate for this site. The chloride content and pH of the samples indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site, whereas the resistivity is indicative of an aggressive corrosive environment.

7.0 Recommendations

It is recommended that the following be carried out once the master plan and site development are determined:

- ❏ Review master grading plan from a geotechnical perspective, once available.
- ❏ Observation of all bearing surfaces prior to the placement of concrete.
- ❏ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.
- ❏ Observation of all subgrades prior to placement of backfilling materials.
- ❏ Field density tests to determine the level of compaction achieved.
- ❏ Sampling and testing of the bituminous concrete including mix design reviews.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon request, following the completion of a satisfactory material testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. We request permission to review the grading plan once available. Also, our recommendations should be reviewed when the drawings and specifications are complete.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Homestead Land Developments or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Oct. 11-2017

Nathan Christie, P.Eng. David J. Gilbert, P.Eng.

Report Distribution:

- ❏ Homestead Land Holdings Ltd. (3 copies)
- ❏ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger **DATE** June 1, 2017

FILE NO. PG4163

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.03
Asphaltic concrete 0.08							
FILL: Brown sand and gravel 0.23		SS	1	42	21		
		SS	2	33	11	1	65.03
FILL: Brown sand and gravel, some silt		SS	3	36	50+		
2.49						2	64.03
Grey fractured limestone **BEDROCK** 3.02		SS	4	71	50+		
						3	63.03
		RC	1	85	69		
BEDROCK: Fair to excellent quality, grey limestone						4	62.03
		RC	2	100	100	5	61.03
5.92							
End of Borehole							
(GWL @ 2.93m - June 8, 2017)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Monitoring Well Construction

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 1, 2017

FILE NO. PG4163

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	65.69		
Asphaltic concrete 0.10									
FILL: Grey-brown sand, some silt		SS	1	62	11				
		SS	2	25	10	1	64.69		
		SS	3	42	5	2	63.69		
2.29									
Grey fractured limestone BEDROCK 2.44		SS	4	100	50+				
End of Borehole									
Practical refusal to augering at 2.44m depth									
(GWL @ 2.31m - June 8, 2017)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger

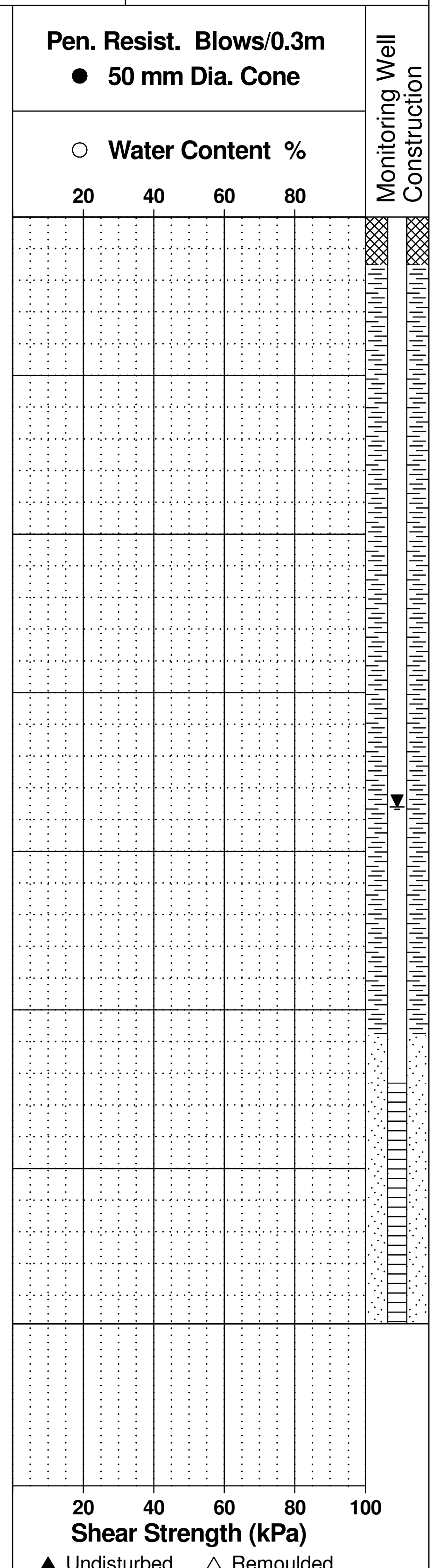
DATE June 1, 2017

FILE NO. PG4163

HOLE NO. BH 3

SOIL DESCRIPTION	Strata depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.09				
FILL: Grey-brown sand, trace silt		SS	1	58	21
		SS	2	33	35
		SS	3	67	18
	2.36	SS	4	88	50+
GLACIAL TILL: Brown silty clay with sand, gravel, fractured rock and boulders		RC	1	94	
		RC	2	67	
	3.99	SS	5	100	50+
BEDROCK: Poor to excellent quality, grey limestone		RC	3	80	60
	6.98	RC	4	100	96
End of Borehole					
(GWL @ 3.72m - June 8, 2017)					

DEPTH (m)	ELEV. (m)
0	65.44
1	64.44
2	63.44
3	62.44
4	61.44
5	60.44
6	59.44



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 1, 2017

FILE NO. PG4163

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	66.05
Asphaltic concrete 0.09							
FILL: Grey-brown sand, trace silt 0.76		SS	1	75	20		
FILL: Brown silty sand, some clay, trace gravel 1.52		SS	2	83	8	1	65.05
GLACIAL TILL: Brown sandy silt, trace clay and gravel		SS	3	75	24	2	64.05
2.39		SS	4	100	50+		
End of Borehole							
Practical refusal to augering at 2.39m depth							
(GWL @ 2.19m - June 8, 2017)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger **DATE** June 1, 2017

FILE NO. PG4163

HOLE NO. BH 5

SOIL DESCRIPTION	Depth of strata (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	65.79
Asphaltic concrete	0.06						
FILL: Brown sand with gravel, trace silt and clay		SS	1	46	57		
		SS	2	42	11	1	64.79
	1.52						
GLACIAL TILL: Brown sand with gravel, trace silt		SS	3	67	39		
	2.06					2	63.79
BEDROCK: Very poor to fair quality, grey limestone		RC	1	81	21		
						3	62.79
		RC	2	64	40		
						4	61.79
		RC	3	100	100	5	60.79
	5.72						
End of Borehole							
(GWL @ 3.20m - June 8, 2017)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

Monitoring Well Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Building - 851 Richmond Road
Ottawa, Ontario

DATUM TBM - Top of grate of catch basin (refer to Dwg. PG4163-1). Geodetic elevation = 65.24m.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 1, 2017

FILE NO. PG4163

HOLE NO. BH 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	65.56		
Asphaltic concrete 0.08									
FILL: Brown sand and gravel, trace silt		SS	1	58	18				
		SS	2	50	45	1	64.56		
		SS	3	42	17				
2.29						2	63.56		
GLACIAL TILL: Brown silty sand with clay and gravel		SS	4	58	13				
						3	62.56		
		SS	5	100	27				
						4	61.56		
		SS	6	100	52				
4.60									
End of Borehole									
Practical refusal to augering at 4.60m depth									
(GWL @ 3.35m - June 8, 2017)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

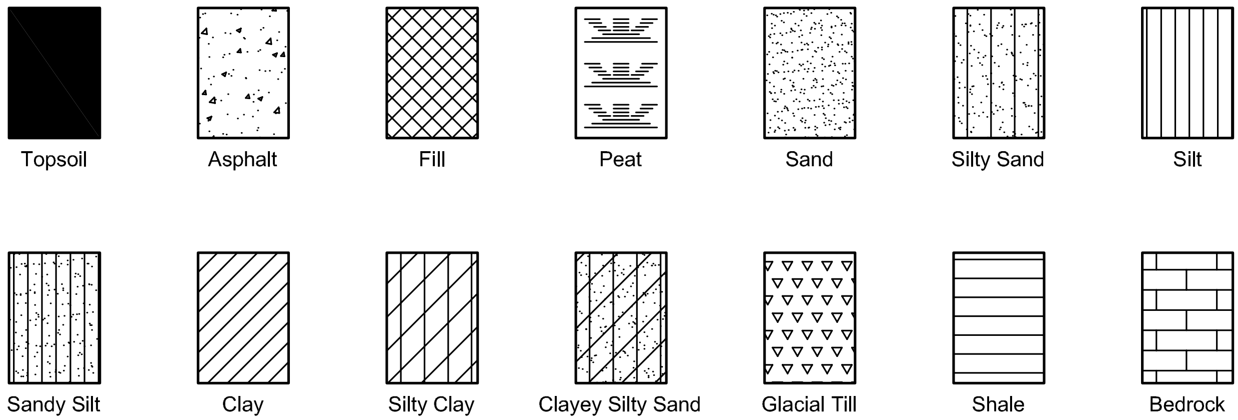
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

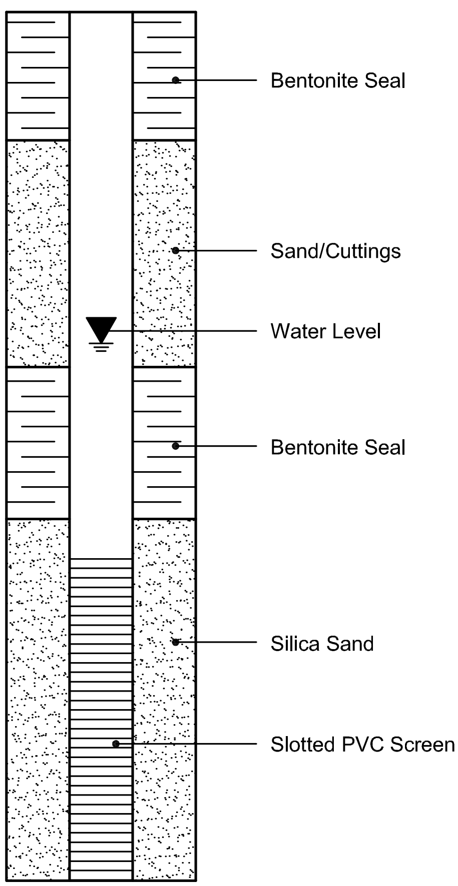
SYMBOLS AND TERMS (continued)

STRATA PLOT

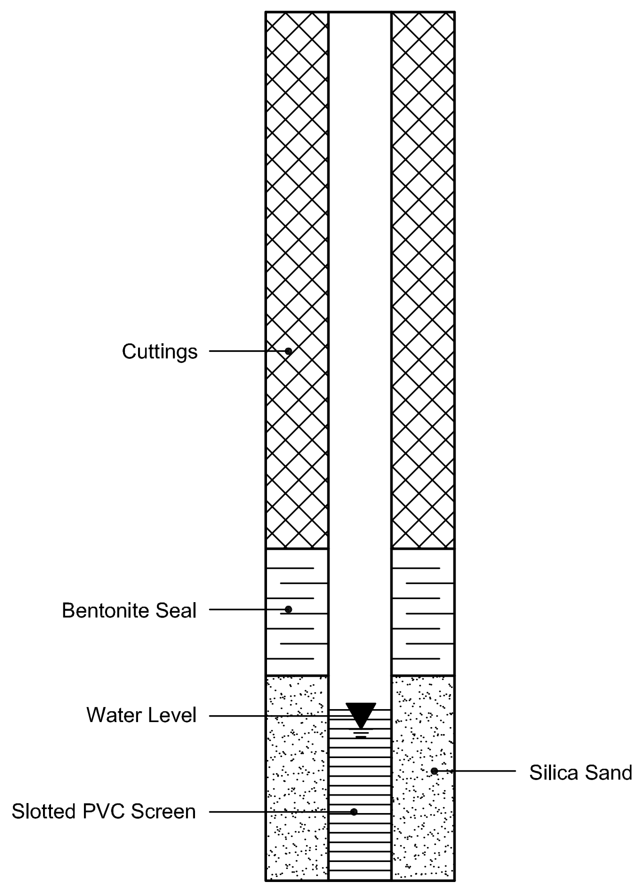


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURES 2 AND 3 - SEISMIC SHEAR WAVE VELOCITY PROFILES

DRAWING PG4163-1 - TEST HOLE LOCATION PLAN

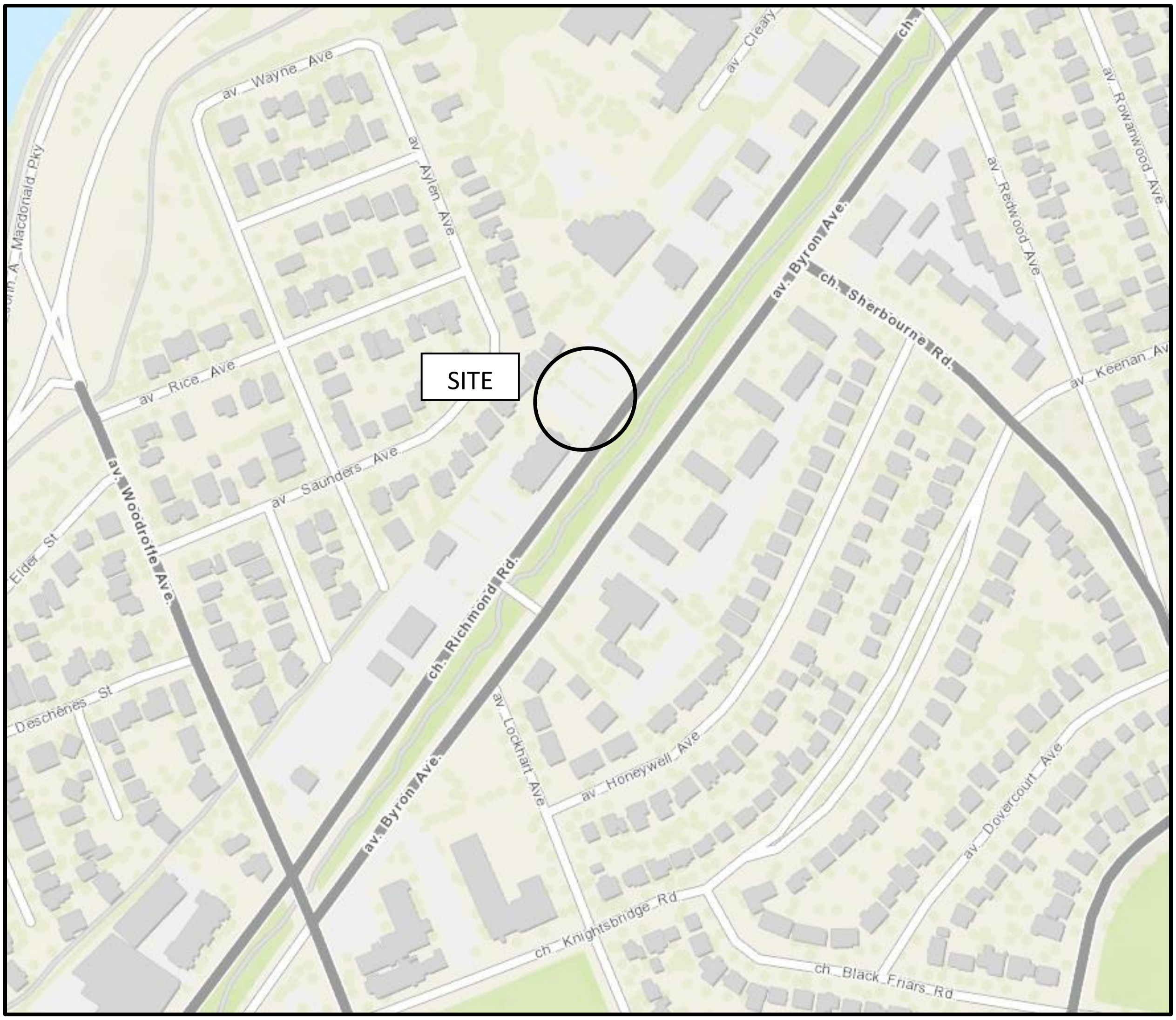


FIGURE 1

KEY PLAN

patersongroup

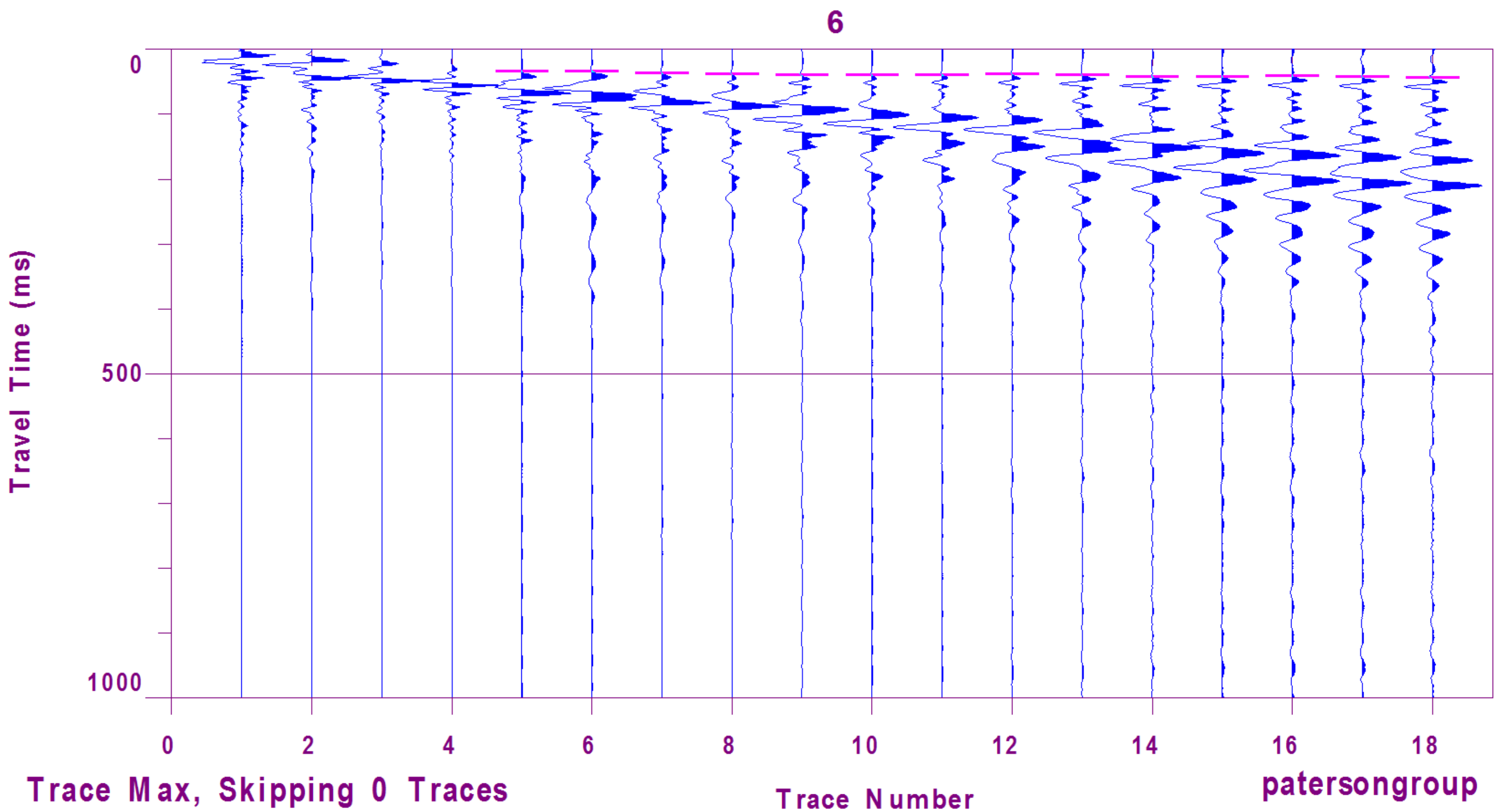


Figure 2 – Shear Wave Velocity Profile at Shot Location -3 m

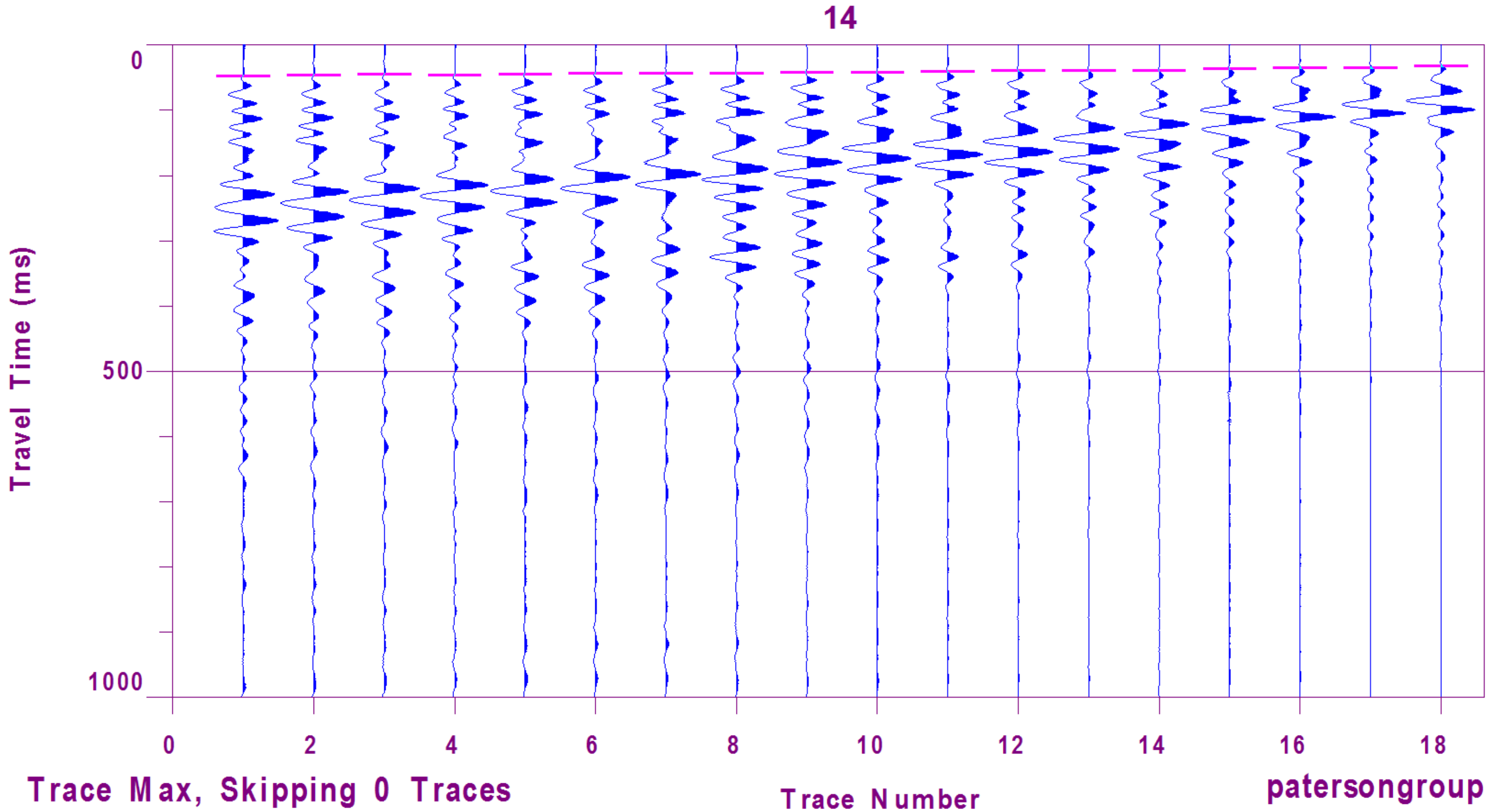
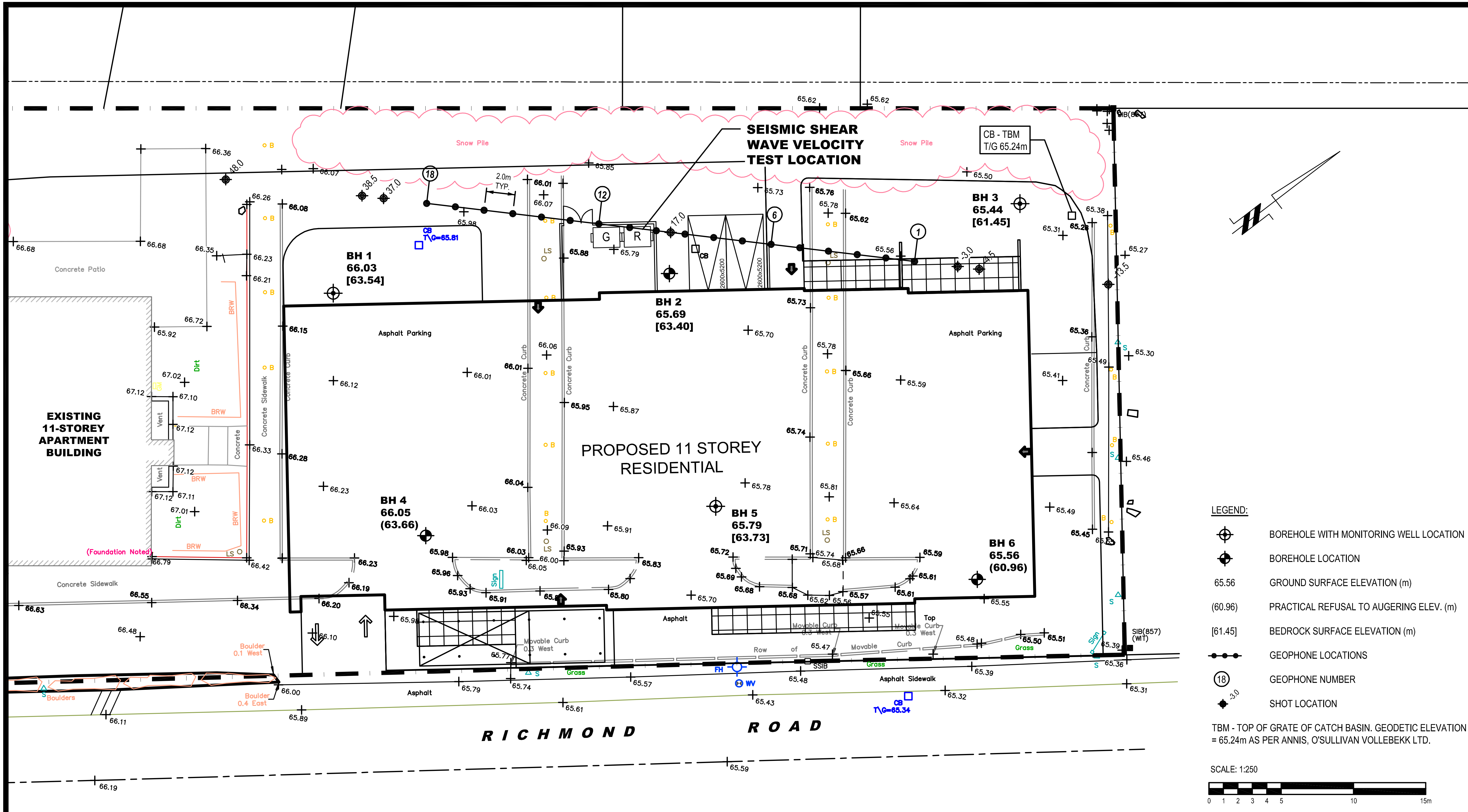


Figure 3 – Shear Wave Velocity Profile at Shot Location 48 m



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NO.	REVISIONS	DATE	INITIAL
0			

HOMESTEAD LAND HOLDINGS

GEOTECHNICAL INVESTIGATION
PROP. MULTI-STOREY BUILDING - 851 RICHMOND ROAD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:250	Date: 06/2017
Drawn by: MPG	Report No.: PG4163-1
Checked by: NC	Dwg. No.: PG4163-1
Approved by: DJG	Revision No.: 0

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APPENDIX 3

Noise and Vibration Study:

Report PG4201-1 Revision 1 dated October 11, 2017

patersongroup

Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Environmental Noise Control And Vibration Study

Proposed Multi-Storey Building
851 Richmond Road - Ottawa

Prepared For

Homestead Land Holdings

August 8, 2017

Report: PG4201-1

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by Homestead Land Holdings to conduct an environmental noise control and vibration study for the proposed multi-storey building to be located at 851 Richmond Road, in the City of Ottawa (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the current study was to:

- ❏ Determine the primary noise sources impacting the site and compare the projected sound levels to guidelines set out by the Ministry of Environment and Climate Change (MOECC) and the City of Ottawa.

- ❏ Review the projected noise levels and offer recommendations regarding warning classes or alternative sound barriers.

- ❏ Review the potential of detrimental vibrations caused by the proposed light rail transit.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes acoustical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

This study has been conducted according to City of Ottawa Engineering Noise Control Guidelines (ENCG), dated January 2016, and the Ontario Ministry of the Environment Guideline NPC-300. The document - Transit Noise and Vibration Impact Assessment, composed by the Department of Transportation of the United States of America, dated May 2006, was also followed for the vibrational analysis.

2.0 Background

It is understood that the proposed development will consist of an eleven (11) storey residential building with two (2) levels of underground parking. It is noted that there is no dedicated outdoor living area (OLA) for this proposed development. Private outdoor terraces are located on several floors, but due to the size limitations, are not designated an OLA and therefore will not be analyzed.

3.0 Methodology and Noise Assessment Criteria

The City of Ottawa outlines three (3) sources of environmental noise that must be analyzed separately:

- Surface Transportation Noise
- Stationary Noise
  - new noise-sensitive development applications (noise receptors) in proximity to existing or approved stationary sources of noise, and
  - new stationary sources of noise (noise generating) in proximity to existing or approved noise-sensitive developments
- Aircraft noise

Surface Transportation Noise

The City of Ottawa's Official Plan, in addition to the ENCG dictate that the following conditions must be satisfied to classify as a surface transportation noise source for a subject site:

- Within 100 m of the right-of-way of an existing or proposed arterial, collector or major collector road; a light rail transit corridor; bus rapid transit, or transit priority corridor
- Within 250 m of the right-of-way for an existing or proposed highway or secondary rail line
- Within 300 m from the right of way of a proposed or existing rail corridor or a secondary main railway line
- Within 500 m of an existing 400 series provincial highway, freeway or principle main railway line.

The NPC-300 outlines the limitations of the stationary and environmental noise levels in relation to the location of the receptors. These can be found in the following tables:

Table 1 - Sound Level Limits for Outdoor Living Areas

Time Period	Required $L_{eq(16)}$ (dBA)
16-hour, 7:00-23:00	55

- Standards taken from Table 2.2a; Sound Level Limit for Outdoor Living Areas - Road and Rail

Table 2 - Sound Level Limits for Indoor Living Area			
Type of Space	**Time Period**	**Required L_{eq} (dBA)**	
		Road	**Rail**
Living/Dining, den areas of residences, hospitals, nursing homes, schools, daycare centres, etc	7:00-23:00	45	40
Theaters, place of worship, libraries, individual or semi-private offices, conference rooms, reading rooms	23:00-7:00	45	40
Sleeping quarters	7:00-23:00	45	40
	23:00-7:00	40	35
❑ Standards taken from Table 2.2b; Sound Level Limit for Indoor Living Areas - Road and Rail			

If the sound level limits are exceeded at the window panes for the indoor living areas, the following Warning Clauses may be referenced:

Table 3 - Warning Clauses for Sound Level Exceedances	
Warning Clause	**Description**
Warning Clause Type A	"Purchasers/tenants are advised that sound levels due to increasing road traffic (rail traffic) (air traffic) may occasionally interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment."
Warning Clause Type B	"Purchasers/tenants are advised that despite the inclusion of noise control features in the development and within the building units, sound levels due to increasing road traffic (rail traffic) (air traffic) may on occasions interfere with some activities of the dwelling occupants as the sound levels exceed the sound level limits of the Municipality and the Ministry of the Environment."
Warning Clause Type C	"This dwelling unit has been designed with the provision for adding central air conditioning at the occupant's discretion. Installation of central air conditioning by the occupant in low and medium density developments will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment."
Warning Clause Type D	"This dwelling unit has been supplied with a central air conditioning system which will allow windows and exterior doors to remain closed, thereby ensuring that the indoor sound levels are within the sound level limits of the Municipality and the Ministry of the Environment."
❑ Clauses taken from section C8 Warning Clauses; Environmental Noise Guidelines - NPC-300	

Stationary Noise

Stationary noise sources include sources or facilities that are fixed or mobile and can cause a combination of sound and vibration levels emitted beyond the property line. These sources may include commercial air conditioner units, generators and fans. Facilities that may contribute to stationary noise may include car washes, snow disposal sites, transit stations and manufacturing facilities.

The impact of stationary noise sources is directly related to the location of the subject site within the urban environment. The proposed development at 851 Richmond Road can be classified as Class 1 by provincial guidelines and outlined in the ENGC, meaning “an area with an acoustical environment typical of a major population centre, where the background sound level is dominated by the activities of people, usually road traffic, often referred to as ‘urban hum.’ The City Class 1 areas generally include all of the urban area as well as lands in proximity to Employment Lands and the 416/417 corridor.”

Table 4 - Guidelines for Stationary Noise - Class 1

Time of Day	Outdoor Point of Reception	Pane of Window
7:00-19:00	50	50
19:00-23:00	50	50
23:00-7:00	-	45

❏ Standards taken from Table 3.2a; Guidelines for Stationary Noise - Steady and Varying Sound

Aircraft/Airport Noise

Aircraft noise is distinct, as it is typically low frequency for longer durations. The sound level may also differ between different types of aircraft. Due to the location of the subject site, an analysis aircraft/airport noise is not required.

4.0 Methodology and Vibration Assessment Criteria

Due to the presence of the future Confederation Line, a ground vibration and ground-borne noise review was also performed for this development.

Effects of the Confederation Line on the Proposed Development

The human body can be affected by exposure to vibration, in particular ground-borne vibrations occurring at low frequencies. These can be caused by the surrounding vibration sources previously identified, which include such as wheels on a road or rail system. These ground-borne vibrations can cause the building to shake (ground-borne vibration) and/or rumbling sounds (ground-borne noise).

The methods of defining and measuring vibrations has its own challenges, based on the oscillatory motion identified as a vibration. Due to the nature of the oscillatory motion of the vibration, there is no net movement of the vibration element, and therefore motion descriptors are zero.

There are two (2) main methods of defining the magnitude of the overall vibration. The main one utilized in construction activities is the peak particle velocity (PPV). The PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal and is often used when monitoring blasting vibrations and is ideal for evaluating the potential of building damage.

However, human responses require a different method of analysis as the human body required time to respond to vibration signals. The average vibration amplitude would be an applicable method of reporting the ground-borne vibrations that humans would respond to, however with the vibration being represented as a sine wave, the average vibration amplitude would be zero. Therefore, the root mean square (RMS) amplitude, typically calculated over a 1 second interval, is utilized for the analysis. The RMS value is always less than the PPV.

General factors that could affect the magnitude of the created vibrations include, but are not limited to, whether the light rail is above grade or below grade, speed, vehicle suspension, wheel and track condition, track support system, depth of system and soil conditions. It should be noted that vibrations that travel through the bedrock surface should be minimal, but can travel a further distance.

It is anticipated that both the construction of the Confederation Line in addition to the day to day operational frequency of the Confederation line will create vibrations that may be experienced within 851 Richmond Road. Vibrations caused by the Confederation Line could propagate through the bedrock surface, and extend to the building foundation at 851 Richmond Road, which in turn could extend the vibration through the remainder of the building.

The City of Ottawa has not defined limits as to the amount of vibration caused by the Confederation Line would be acceptable. In a document released to the Council on December 4, 2012, titled "Design, Build, Finance and Maintenance of Ottawa Light Rail Transit (OLRT) Project", submitted by Ms. Nancy Schepers, it states that:

> That assessment has established a noise and vibration standard that will protect all buildings including highly sensitive receptors like the CBC building on Queen Street and the National Arts Centre on Elgin Street.
>
> Noise levels in these sensitive receptors will be baselined and RTG will work with the institutions to meet performance specifications and coordinate construction activities to minimize impacts on their institution's operations.
>
> Following the assessment, RTG will develop specific noise and vibration mitigation measures as part of the project's final design and will maintain the light rail system to ensure that the mitigation measures remain effective in the future during normal operations.
>
> While some construction-related noise will be unavoidable as the Confederation Line is being built, RTG's construction methods and mitigation strategies will minimize disruption to the best extent possible.

Therefore, the Federal Transit Administration's Transit Noise and Vibration Impact Assessment Report: FTA-VA-90-1003-06 was utilized as the standard for vibration standards caused by light rail. Upon review of these documents, the following standards were obtained that are applicable to this analysis.

The criteria for the environmental impact from vibrations are based on the RMS vibration levels for repeated events. The proposed development would be classified as a Vibration Category 2 - Residential. This includes all locations where people would sleep. The following table outlines the limits for ground-borne vibrations.

Table 5 - Ground-Borne Vibration (GBV) for General Assessment			
Land Use Category	**GBV Impact Levels (VdB re 1 micro-inch/sec)**		
	Frequent Events	**Occasional Events**	**Infrequent Events**
Category 2	72 VdB	75 VdB	80 VdB

Notes:

- ❏ Frequent events is defined as more than 70 vibration events of the same source per day. Most rapid transit projects fall into this category.
- ❏ Occasional events is define as between 30 and 70 vibration events of the same source per day. Most commuter trunk lines have this many operations.
- ❏ Infrequent events is defined as fewer tan 30 vibration events of the same kind per day. This category includes most commuter rail branch lines.

The Confederation Line is classified as a light rail transit. According to the DOT - Transit Noise and Vibration Impact Assessment, the description of a light rail transit would be that "the ground-borne vibration characteristics of light rail systems are very similar to those of rapid transit systems. Because the speeds of light rail systems are usually lower, the typical vibration levels usually are lower." This document also outlines screening radiuses, defined as where there is a potential for disturbing ground-borne vibrations, where additional studies should be completed. For a source of light rail transit within a category 2 classification, the screening distance for vibration assessment is 45 m (150'). The proposed development will be within this radius.

5.0 Analysis

5.1 Noise Attentuation Study

The proposed development is bordered to the southeast by Richmond Road and Byron Avenue. Residential and commercial development surround the proposed development on the remaining boundaries. Saunders Avenue is also located with the 100 m radius around the proposed development. However, Saunders Avenue is not identified as an arterial or collector road and therefore is not considered in this study.

It is understood that the Ottawa Light Rail Transit (OLRT) is proposing that the Confederation Line will be located either below Richmond Road or below Byron Avenue. It is understood that, at this time, the exact location and details of this proposed transit line is not known, and will not be finalized until 2018. For the issuance of this noise and vibration study, it is assumed that the Confederation Line will be located below Richmond Road (the closest possible proximity to the proposed development), at a depth of 10 m below the existing ground level.

Noise source locations are presented on Paterson Drawing PG4201-1 - Site Plan, located in Appendix 1.

There are no stationary noise or aircraft noise sources within the influence area.

The noise levels from road traffic are designated by the City of Ottawa, taking into consideration the right-of-way width and the implied roadway class. It is understood that these values represent the maximum allowable capacity of the proposed roadways.

The parameters to be used for sound level predictions can be found below.

Table 6 - Traffic and Road Parameters

Road	Implied Roadway	AADT (Veh/day)	Posted Speed (km/h)	Day/Night Split %	Medium Truck %	Heavy Truck %
Richmond Road	2-UAU	15000	50	92/8	7	5
Byron Avenue	2-UCU	8000	50	92/8	7	5

- Data obtained from the City of Ottawa document ENCG

The projected noise levels from the Confederation Line were provided by the City of Ottawa, taking into consideration the number of trips, the speed of the light rail and the type of engin. This information was provided to Paterson in an e-mail correspondence and is summarized below.

Table 7 - Light Rail Parameters

Light Rail Line	Engine Type	Maximum Speed (km/hr)	Number of Trips	Length of Train
Confederation Line	Electric	65	488	2

There were several reception points that were considered in our analysis of the proposed multi-storey building. Reception points were selected at the bedroom windows along the different building elevations that are exposed to the identified noise sources. For this analysis, a reception point was taken at the centre of the window pane, at several different floor levels. Reception points are noted on Paterson Drawing PG4201-2 - Receptor Locations, presented in Appendix 1.

Table 10 - Summary of Reception Points and Geometry, presented in Appendix 1, provides a summary of the points of reception and their geometry with respect to the noise sources.

The analysis was completed using STAMSON version 5.04, a computer program which uses the road and rail traffic noise prediction methods using ORNAMENT (Ontario Road Noise Analysis Method for Environment and Transportation) and STEAM (Sound from Trains Environment Analysis Method), publications from the Ontario Ministry of Environment and Energy.

5.2 Vibration Assessment

At the time of the study, the design details of the Confederation Line is not known. Therefore, all analysis will need to be completed on a projected data basis (i.e. no direct monitoring of the existing conditions). The following assumptions were used for the completion of this study.

It is understood that the Confederation Line will be constructed at a minimum, of 15 m horizontally from the proposed building perimeter (measured from the proposed building to the centre of the rail line). The vertical distance is not applicable as both structures will be founded within the bedrock, at similar elevations.

The following figure is a base curve for ground surface vibration levels, assuming the equipment is in good condition and speeds of 80 km/hr (50 mph) are not exceeded. Due to the nature of the Confederation Line, this table is applicable for the proposed development.

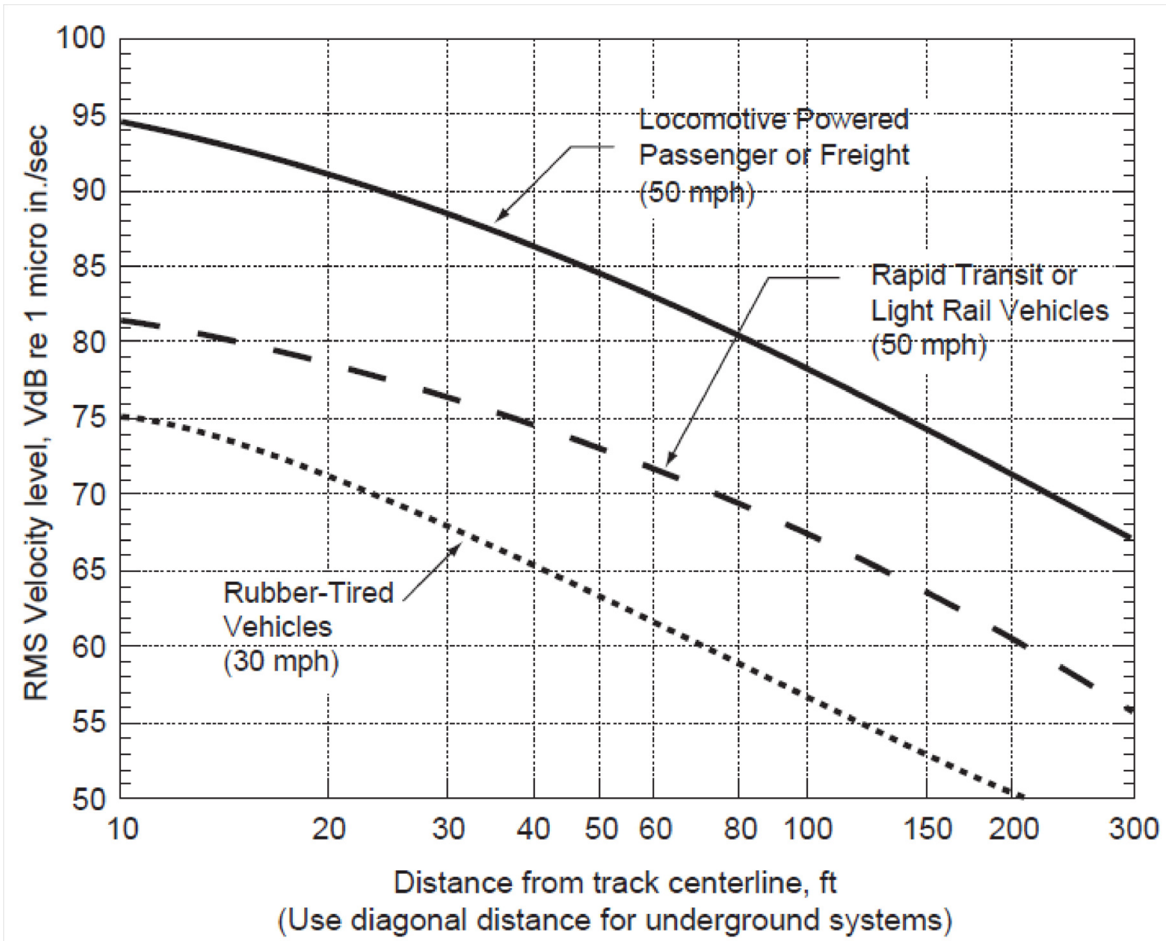

Figure 1 - Generalized Ground Surface Vibration Curve

6.0 Results

6.1 Noise Attenuation Results

The primary descriptors are the 16-hour daytime and the 8-hour night time equivalent sound levels, $L_{eq(16)}$ and the $L_{eq(8)}$ for City roads.

The proposed traffic noise levels were analyzed at all reception points. The results of the STAMSON software can be located in Appendix 2, and the summary of the results can be noted in Table 8.

Table 8 - Proposed Noise Levels

Reception Point	Description	Daytime at Facade $L_{EQ(16)}$ (dBA)	Nighttime at Facade $L_{eq(8)}$ (dBA)
REC 1-1	Eastern Elevation, 1st floor	69.65	61.62
REC 1-5	Eastern Elevation, 5th floor	70.75	61.62
REC 1-11	Eastern Elevation, 11th floor	70.75	61.62
REC 2-1	Northern Elevation, 1st floor	63.78	56.12
REC 2-5	Northern Elevation, 5th floor	64.07	56.13
REC 2-11	Northern Elevation, 11th floor	64.25	56.17
REC 3-1	Southern Elevation, 1st floor	61.56	53.89
REC 3-5	Southern Elevation, 5th floor	61.87	53.89
REC 3-11	Southern Elevation, 11th floor	61.87	53.89

6.2 Vibration Assessment Results

Based on Figure 1, for a Category 2 structure, the Confederation would need to be constructed 18 m (measured from the centre of the track to the building perimeter) in order to keep the RMS velocity level below 72 VdB. As calculated, at the closest proximity to the proposed building, the Confederation Line will be 15 m. At 15 m, the RMS velocity will be 73 VdB.

7.0 Discussion and Recommendations - Noise Attenuation

As described in Tables 1 and 2, where the sound levels exceed the limits for either the indoor or outdoor receptors, noise control measures should be implemented.

The MOECC, lists the following options for sound mitigation:

- ❑ Distance set back with soft ground
- ❑ Insertion of noise insensitive land uses between the source and sensitive receptor
- ❑ Orientation of buildings to provide sheltered zones or modified interior spaces (room and corridor arrangement) and amenity areas
- ❑ Enhanced construction techniques and construction quality (e.g. brick veneers, multi-pane windows).
- ❑ Earth berms (sound barriers)
- ❑ Indoor isolation - air conditioning and ventilation, enhanced dampening materials (indoor isolation)

It should be noted that it is not possible to provide additional set-backs with soft ground from the identified noise sources and the orientation of the building has already been positioned to minimize the amount of noise on any outdoor living areas. Therefore, the sound mitigation method that will be implemented for this proposed development will include a review of the construction techniques and construction materials. It is not anticipated that earth berms or sound barriers will be required for this development.

7.1 Outdoor Living Areas

There were no outdoor living areas prescribed for the aforementioned development.

7.2 Indoor Living Areas and Ventilation

The results of the STAMSON modelling indicates that the $L_{eq(16)}$ ranges between 61.56 dBA and 70.75 dBA. These values exceed the limit of 45 dBA as specified in Table 2 and therefore warning clauses will be required to be stated on any property titles. The applicable warning clauses are summarized in Table 9 on the following page.

Table 9 - Summary of Warning Clauses			
Elevation	**Floor**	**Applicable Warning Clause**	**Additional Considerations**
East	All	Warning Clause Type D	All units must be equipped with a central air conditioning system, reducing the need to open windows. Additionally, building components including windows, walls and doors, where applicable, should be designed so that the indoor sound levels comply with the sound level limits in Table 2.
North	All	Warning Clause Type C	All units must be equipped with a central air conditioning system, reducing the need to open windows.
South	All	Warning Clause Type C	All units must be equipped with a central air conditioning system, reducing the need to open windows.

7.3 Noise Control Measures for Surface Transportation Noise

As described in Table 8, where the daytime sound level at the plane of the window exceeds 65 dBA, as noted on the eastern elevation, noise control measures should be implemented.

It should be noted that it is not possible to provide additional set-backs with soft ground from the identified noise sources and the orientation of the building has already been positions to minimize the amount of noise on any outdoor living areas. Therefore, the sound mitigation method that will be implemented for this proposed development will include a review of the construction techniques and construction materials. It is not anticipated that earth berms or sound barriers will be required for this development.

Proposed Construction Specifications

The MOECC states that, where the $L_{eq(24)}$ exceeds 60 dBA, the exterior walls next to the proposed rail line (the Confederation Line) are to be clad, as a minimum, of a brick veneer or masonry equivalent construction.

Otherwise, construction materials are not specified yet for the proposed building.

Sound Transmission Class (STC) is the single-number rating for describing sound transmission loss of a wall or partition. This is the most popular way of determining the construction materials that would be sufficient to reduce the rail and road noise. Based on the analysis of the environmental noise study, building materials with an STC value of 30 or higher is sufficient for this development.

8.0 Discussion and Recommendations - Vibration Assessment

Since specifics are not known for the proposed Confederation Line, the analysis was completed using known industry standards.

Based on the standard information provided on Figure 1, there is a slight exceedance of 1 VdB. An exceedance of 1 VdB should not be detrimental to the living environment at the proposed development and is considered acceptable. However, it should be noted that this measurement is based on theoretical values as the Confederation Line is not yet operational. There are several factors that could lower the proposed vibration:

- ❏ The true alignment of the Confederation Line. If the alignment of the Confederation Line is further than 18 m from the edge of the building, than the RMS value should be below the 72 VdB threshhold.
- ❏ Figure 1 is based on light rail transit travelling at speeds of 80 km/hr (50 mph). Upon discussion with the City of Ottawa, it is anticipated that the light transit will be traveling at speeds between 45-60 km/hr. This lowering of the speed will cause a reduction in the magnitude of the vibrations caused.
- ❏ The true founding conditions of both the proposed building and the Confederation Line. It has been studied that foundations on bedrock (both for the proposed building and the Confederation Line) will dampen the vibration effects, causing a lower overall RMS value at the proposed building. However, the true dampening will need to be measured in the field once the Confederation Line has been constructed.
- ❏ The City of Ottawa has stated that they will take several mitigation factors during construction in order to reduce the amount of vibrations caused by the Confederation Line. Once again, the true dampening will need to be measured in the field once the Confederation Line has been constructed.

Therefore, there will be no excessive vibrations on the proposed development as caused by the Confederation Line.

9.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project. Our recommendations should be reviewed when the project drawings and specifications are complete.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Homestead Land Holdings or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Stephanie A. Boisvenue, P.Eng.

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APPENDIX 1

TABLE 10 - SUMMARY OF RECEPTION POINTS AND GEOMETRY

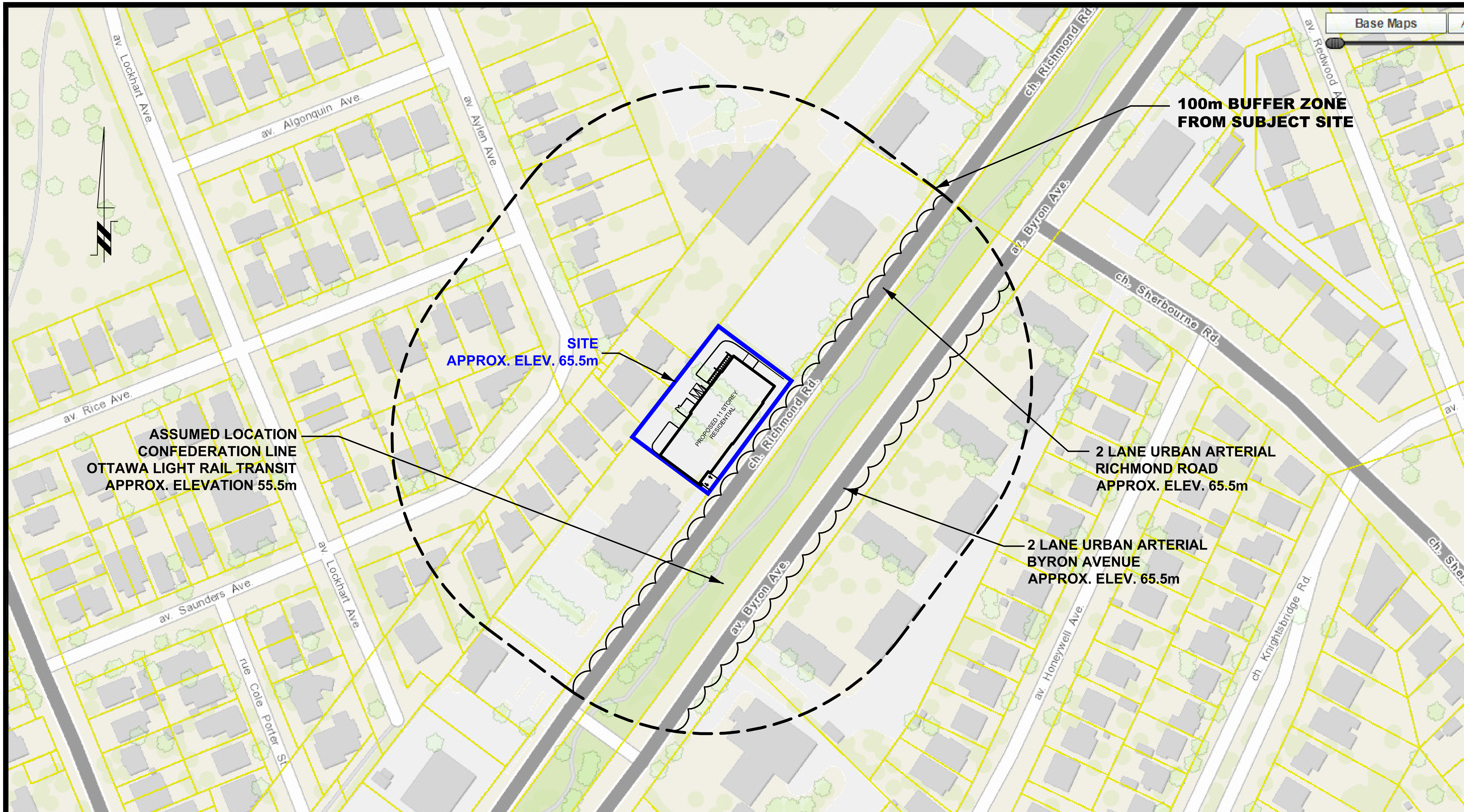
DRAWING PG4201-1 - SITE PLAN

DRAWING PG4201-2 - RECEPTOR LOCATIONS

Table 10 - Summary of Reception Points and Geometry
851 Richmond Road

Point of Reception	Location	Leq Day (dBA)	Richmond Road						Byron Avenue					
			Horizontal (m)	Vertical (m)	Total (m)	Local Angle (degree)	Barrier Height (m)	Distance (m)	Horizontal (m)	Vertical (m)	Total (m)	Local Angle (degree)	Barrier Height (m)	Distance (m)
REC 1-1	Eastern Elevation, 1st floor	69.65	15	1.5	15.07481	-90, 90	n/a	n/a	47	1.5	47.02393	-90, 90	n/a	n/a
REC 1-5	Eastern Elevation, 5th floor	70.75	15	13.9	20.45018	-90, 90	n/a	n/a	47	13.9	49.012345	-90, 90	n/a	n/a
REC 1-11	Eastern Elevation, 5th floor	70.75	15	31.3	34.70864	-90, 90	n/a	n/a	47	31.3	56.468487	-90, 90	n/a	n/a
REC 2-1	Northern Elevation, 1st floor	63.78	25	1.5	25.04496	8, 90	n/a	n/a	60	1.5	60.018747	8, 90	n/a	n/a
REC 2-5	Northern Elevation, 5th floor	64.07	25	13.9	28.60437	8, 90	n/a	n/a	60	13.9	61.589041	8, 90	n/a	n/a
REC 2-11	Northern Elevation, 11th floor	64.25	25	31.3	40.05858	8, 90	n/a	n/a	60	31.3	67.673407	8, 90	n/a	n/a
REC 3-1	Southern Elevation, 1st floor	61.56	25	1.5	25.04496	-90, -41	n/a	n/a	60	1.5	60.018747	-90, -41	n/a	n/a
REC 3-5	Southern Elevation, 5th floor	61.87	25	13.9	28.60437	-90, -41	n/a	n/a	60	13.9	61.589041	-90, -41	n/a	n/a
REC 3-11	Southern Elevation, 11th floor	61.87	25	31.3	40.05858	-90, -41	n/a	n/a	60	31.3	67.673407	-90, -41	n/a	n/a

Point of Reception	Location	Leq Day (dBA)	Proposed Confederation Line					
			Horizontal (m)	Vertical (m)	Total (m)	Local Angle (degree)	Barrier Height (m)	Distance (m)
REC 1-1	Eastern Elevation, 1st floor	69.65	15	11.5	18.90106	-90, 90	10	2
REC 1-5	Eastern Elevation, 5th floor	70.75	15	23.9	28.21719	-90, 90	10	2
REC 1-11	Eastern Elevation, 5th floor	70.75	15	41.3	43.93962	-90, 90	10	2
REC 2-1	Northern Elevation, 1st floor	63.78	25	11.5	27.51818	8, 90	10	2
REC 2-5	Northern Elevation, 5th floor	64.07	25	23.9	34.58627	8, 90	10	2
REC 2-11	Northern Elevation, 11th floor	64.25	25	41.3	48.27722	8, 90	10	2
REC 3-1	Southern Elevation, 1st floor	61.56	25	11.5	27.51818	-90, -41	10	2
REC 3-5	Southern Elevation, 5th floor	61.87	25	23.9	34.58627	-90, -41	10	2
REC 3-11	Southern Elevation, 11th floor	61.87	25	41.3	48.27722	-90, -41	10	2



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NO.	REVISIONS	DATE	INITIAL
0			

HOMESTEAD LAND HOLDINGS

NOISE AND VIBRATION STUDY
851 RICHMOND ROAD

OTTAWA, ONTARIO

Title:

SITE PLAN

Scale: 1:1500	Date: 07/2017
Drawn by: MPG	Report No.: PG4201-1
Checked by: SB	Dwg. No.: PG4201-1
Approved by: DJG	Revision No.: 0

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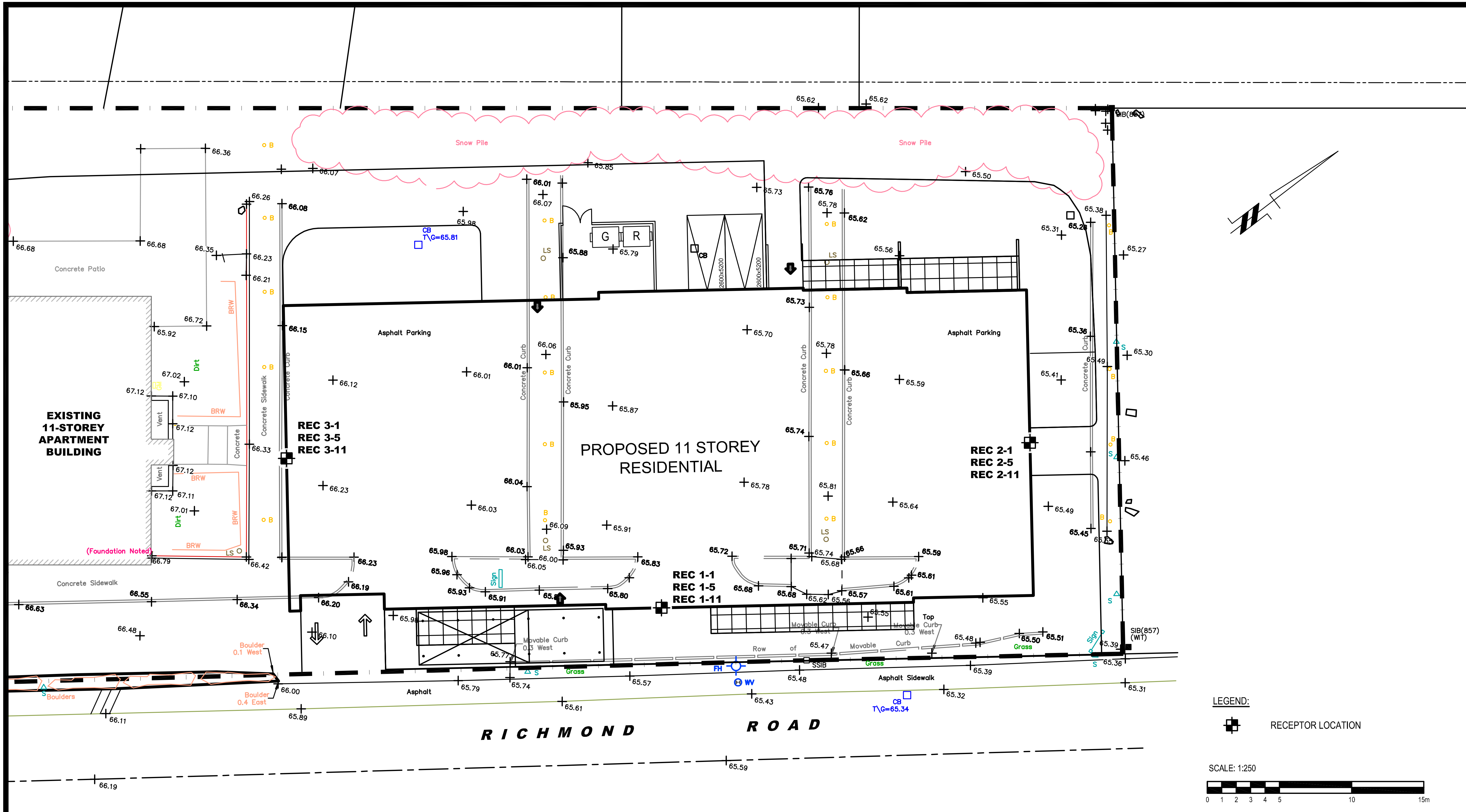

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NO.	REVISIONS	DATE	INITIAL
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HOMESTEAD LAND HOLDINGS
NOISE AND VIBRATION STUDY
851 RICHMOND ROAD
OTTAWA, ONTARIO

Title:
RECEPTOR LOCATION PLAN

Scale: 1:250	Date: 07/2017
Drawn by: MPG	Report No.: PG4201-1
Checked by: SB	Dwg. No.: PG4201-2
Approved by: DJG	Revision No.: 0

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APPENDIX 2

STAMSON RESULTS

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 34:40:56
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC11.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 1-1


Rail data, segment # 1: OLRT (day/night)
---------------------------------------
Train            ! Trains       ! Speed !# loc !# Cars! Eng  !Cont
Type             !              !(km/h) !/Train!/Train! type !weld
-----------------+--------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0    !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:          ! Unadj. ! Annual % ! Years of !
 No  Name            ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT            ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  15.00 / 15.00  m
Receiver height            :   1.50 / 1.50   m
Topography                 :      4       (Elevated; with barrier)
No Whistle
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  10.00 m
Elevation                  :  10.00 m
Barrier receiver distance :   3.00 / 2.00   m
Source elevation           :   0.00 m
Receiver elevation         :  10.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !        1.50 !       10.00 !        10.00
       0.50 !        1.50 !        9.30 !         9.30

LOCOMOTIVE (0.00 + 57.58 + 0.00) = 57.58 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90     90   0.00  62.58   0.00   0.00   0.00   0.00  -5.00  57.58
---------------------------------------------------------------------

WHEEL (0.00 + 56.00 + 0.00) = 56.00 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90     90   0.00  62.59   0.00   0.00   0.00   0.00  -6.59  56.00
```

Segment Leq : 59.87 dBA

Total Leq All Segments: 59.87 dBA

♀
Results segment # 1: OLRT (night)

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
4.00	1.50	10.50	10.50
0.50	1.50	10.03	10.03

LOCOMOTIVE (0.00 + 39.33 + 0.00) = 39.33 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	39.33	0.00	0.00	0.00	0.00	-2.97	36.37*
-90	90	0.00	39.33	0.00	0.00	0.00	0.00	0.00	39.33

* Bright Zone !

WHEEL (0.00 + 39.34 + 0.00) = 39.34 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	39.34	0.00	0.00	0.00	0.00	-4.99	34.35*
-90	90	0.00	39.34	0.00	0.00	0.00	0.00	0.00	39.34

* Bright Zone !

Segment Leq : 42.35 dBA

Total Leq All Segments: 42.35 dBA

♀
Road data, segment # 1: Richmond (day/night)

```
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

* Refers to calculated road volumes based on the following input:

```
    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00
```

Data for Segment # 1: Richmond (day/night)

```
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
```

```
No of house rows          :      0 / 0
Surface                   :      2        (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1        (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00  68.48
----------------------------------------------------------------------------

Segment Leq : 68.48 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.79 + 0.00) = 60.79 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90     90   0.00  65.75   0.00  -4.96   0.00   0.00   0.00   0.00  60.79
----------------------------------------------------------------------------
```

Segment Leq : 60.79 dBA

Total Leq All Segments: 69.16 dBA

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	60.88	0.00	0.00	0.00	0.00	0.00	0.00	60.88

Segment Leq : 60.88 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 53.20 + 0.00) = 53.20 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	58.16	0.00	-4.96	0.00	0.00	0.00	0.00	53.20

Segment Leq : 53.20 dBA

Total Leq All Segments: 61.56 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 69.65
(NIGHT): 61.62

♀
♀

```
STAMSON 5.0        NORMAL REPORT        Date: 26-07-2017 34:45:24
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC111.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 1-11


Rail data, segment # 1: OLRT (day/night)
----------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  15.00 / 15.00  m
Receiver height            :  31.30 / 31.30  m
Topography                 :      4       (Elevated; with barrier)
No Whistle
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  10.00 m
Elevation                  :  10.00 m
Barrier receiver distance  :   3.00 / 3.00   m
Source elevation           :   0.00 m
Receiver elevation         :  10.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !       31.30 !       33.84 !        33.84
       0.50 !       31.30 !       33.14 !        33.14

LOCOMOTIVE (0.00 + 62.58 + 0.00) = 62.58 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  62.58   0.00   0.00   0.00   0.00  -0.02  62.56*
   -90     90   0.00  62.58   0.00   0.00   0.00   0.00   0.00  62.58
----------------------------------------------------------------------

 * Bright Zone !

WHEEL (0.00 + 62.59 + 0.00) = 62.59 dBA
```

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	62.59	0.00	0.00	0.00	0.00	-0.02	62.56*
-90	90	0.00	62.59	0.00	0.00	0.00	0.00	0.00	62.59

* Bright Zone !

Segment Leq : 65.60 dBA

Total Leq All Segments: 65.60 dBA

♀
Results segment # 1: OLRT (night)

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
4.00	31.30	33.84	33.84
0.50	31.30	33.14	33.14

LOCOMOTIVE (0.00 + 39.33 + 0.00) = 39.33 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	39.33	0.00	0.00	0.00	0.00	-0.02	39.32*
-90	90	0.00	39.33	0.00	0.00	0.00	0.00	0.00	39.33

* Bright Zone !

WHEEL (0.00 + 39.34 + 0.00) = 39.34 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	39.34	0.00	0.00	0.00	0.00	-0.02	39.32*
-90	90	0.00	39.34	0.00	0.00	0.00	0.00	0.00	39.34

* Bright Zone !

Segment Leq : 42.35 dBA

Total Leq All Segments: 42.35 dBA

♀
Road data, segment # 1: Richmond (day/night)

```
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

* Refers to calculated road volumes based on the following input:

```
    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
```

```
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00  68.48
----------------------------------------------------------------------------

Segment Leq : 68.48 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m
```

ROAD (0.00 + 60.79 + 0.00) = 60.79 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	65.75	0.00	-4.96	0.00	0.00	0.00	0.00	60.79

Segment Leq : 60.79 dBA

Total Leq All Segments: 69.16 dBA

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	60.88	0.00	0.00	0.00	0.00	0.00	0.00	60.88

Segment Leq : 60.88 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 53.20 + 0.00) = 53.20 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	58.16	0.00	-4.96	0.00	0.00	0.00	0.00	53.20

Segment Leq : 53.20 dBA

Total Leq All Segments: 61.56 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 70.75
(NIGHT): 61.62

♀
♀

```
STAMSON 5.0        NORMAL REPORT      Date: 26-07-2017 34:43:51
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC15.te             Time Period: Day/Night 16/8 hours
Description: Reception Point 1-5


Rail data, segment # 1: OLRT (day/night)
----------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   90.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  15.00 / 15.00  m
Receiver height            :  13.90 / 13.90  m
Topography                 :      4       (Elevated; with barrier)
No Whistle
Barrier angle1             : -90.00 deg   Angle2 : 90.00 deg
Barrier height             :  10.00 m
Elevation                  :  10.00 m
Barrier receiver distance  :   3.00 / 3.00   m
Source elevation           :   0.00 m
Receiver elevation         :  10.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !       13.90 !       19.92 !        19.92
       0.50 !       13.90 !       19.22 !        19.22

LOCOMOTIVE (0.00 + 62.58 + 0.00) = 62.58 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  62.58   0.00   0.00   0.00   0.00  -0.03  62.55*
   -90     90   0.00  62.58   0.00   0.00   0.00   0.00   0.00  62.58
----------------------------------------------------------------------

 * Bright Zone !

WHEEL (0.00 + 62.59 + 0.00) = 62.59 dBA
```

```
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  62.59   0.00   0.00   0.00   0.00  -0.05  62.54*
   -90     90   0.00  62.59   0.00   0.00   0.00   0.00   0.00  62.59
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 65.60 dBA

Total Leq All Segments: 65.60 dBA

♀
Results segment # 1: OLRT (night)
---------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !       13.90 !       19.92 !        19.92
       0.50 !       13.90 !       19.22 !        19.22

LOCOMOTIVE (0.00 + 39.33 + 0.00) = 39.33 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  39.33   0.00   0.00   0.00   0.00  -0.03  39.30*
   -90     90   0.00  39.33   0.00   0.00   0.00   0.00   0.00  39.33
----------------------------------------------------------------------

 * Bright Zone !

WHEEL (0.00 + 39.34 + 0.00) = 39.34 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90     90   0.00  39.34   0.00   0.00   0.00   0.00  -0.05  39.30*
   -90     90   0.00  39.34   0.00   0.00   0.00   0.00   0.00  39.34
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 42.35 dBA

Total Leq All Segments: 42.35 dBA

♀
Road data, segment # 1: Richmond (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
```

```
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  15.00 / 15.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  47.00 / 47.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 68.48 + 0.00) = 68.48 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------------
   -90     90   0.00  68.48   0.00   0.00   0.00   0.00   0.00   0.00  68.48
-----------------------------------------------------------------------------

Segment Leq : 68.48 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m
```

ROAD (0.00 + 60.79 + 0.00) = 60.79 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	65.75	0.00	-4.96	0.00	0.00	0.00	0.00	60.79

Segment Leq : 60.79 dBA

Total Leq All Segments: 69.16 dBA

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 60.88 + 0.00) = 60.88 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	60.88	0.00	0.00	0.00	0.00	0.00	0.00	60.88

Segment Leq : 60.88 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 53.20 + 0.00) = 53.20 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	90	0.00	58.16	0.00	-4.96	0.00	0.00	0.00	0.00	53.20

Segment Leq : 53.20 dBA

Total Leq All Segments: 61.56 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 70.75
(NIGHT): 61.62

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 36:29:05
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC21.te             Time Period: Day/Night 16/8 hours
Description: Reception Point 2-1


Rail data, segment # 1: OLRT (day/night)
---------------------------------------
Train            ! Trains        ! Speed !# loc !# Cars! Eng  !Cont
Type             !               !(km/h) !/Train!/Train! type !weld
-----------------+---------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0     !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:          ! Unadj. ! Annual % ! Years of !
 No  Name            ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT            ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            :   8.00 deg   Angle2 : 90.00 deg
Barrier height            :  10.00 m
Elevation                 :  10.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :  10.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver     ! Barrier      ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !        1.50 !        6.10 !         6.10
       0.50 !        1.50 !        3.58 !         3.58

LOCOMOTIVE (0.00 + 43.10 + 0.00) = 43.10 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
     8     90   0.00  62.58  -2.22  -3.41   0.00   0.00 -13.84  43.10
-------------------------------------------------------------------------

WHEEL (0.00 + 40.71 + 0.00) = 40.71 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-------------------------------------------------------------------------
     8     90   0.00  62.59  -2.22  -3.41   0.00   0.00 -16.24  40.71
```

```
------------------------------------------------------------------------

Segment Leq : 45.08 dBA

Total Leq All Segments: 45.08 dBA

♀
Results segment # 1: OLRT (night)
---------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !        1.50 !        6.10 !         6.10
       0.50 !        1.50 !        3.58 !         3.58

LOCOMOTIVE (0.00 + 19.86 + 0.00) = 19.86 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
     8     90   0.00  39.33  -2.22  -3.41   0.00   0.00 -13.84  19.86
------------------------------------------------------------------------

WHEEL (0.00 + 17.47 + 0.00) = 17.47 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
------------------------------------------------------------------------
     8     90   0.00  39.34  -2.22  -3.41   0.00   0.00 -16.24  17.47
------------------------------------------------------------------------

Segment Leq : 21.84 dBA

Total Leq All Segments: 21.84 dBA

♀
Road data, segment # 1: Richmond (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  60.00 / 60.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.85 + 0.00) = 62.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
     8     90   0.00  68.48   0.00  -2.22  -3.41   0.00   0.00   0.00  62.85
----------------------------------------------------------------------------

Segment Leq : 62.85 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.31 + 0.00) = 56.31 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
     8     90   0.00  65.75   0.00  -6.02  -3.41   0.00   0.00   0.00  56.31
----------------------------------------------------------------------------

Segment Leq : 56.31 dBA

Total Leq All Segments: 63.72 dBA

♀
Results segment # 1: Richmond (night)
```

Source height = 1.50 m

ROAD (0.00 + 55.25 + 0.00) = 55.25 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	60.88	0.00	-2.22	-3.41	0.00	0.00	0.00	55.25

Segment Leq : 55.25 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 48.72 + 0.00) = 48.72 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	58.16	0.00	-6.02	-3.41	0.00	0.00	0.00	48.72

Segment Leq : 48.72 dBA

Total Leq All Segments: 56.12 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 63.78
(NIGHT): 56.12

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 36:55:33
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC211.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 2-11


Rail data, segment # 1: OLRT (day/night)
----------------------------------------
Train            ! Trains        ! Speed !# loc !# Cars! Eng  !Cont
Type             !               !(km/h) !/Train!/Train! type !weld
-----------------+---------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0     !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            :   8.00 deg   Angle2 : 90.00 deg
Barrier height            :  10.00 m
Elevation                 :  10.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :  10.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !       31.30 !       14.44 !        14.44
       0.50 !       31.30 !       11.92 !        11.92

LOCOMOTIVE (0.00 + 56.94 + 0.00) = 56.94 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  62.58  -2.22  -3.41   0.00   0.00  -0.22  56.73*
     8     90   0.00  62.58  -2.22  -3.41   0.00   0.00   0.00  56.94
----------------------------------------------------------------------

 * Bright Zone !

WHEEL (0.00 + 56.95 + 0.00) = 56.95 dBA
```

```
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  62.59  -2.22  -3.41   0.00   0.00  -2.57  54.38*
     8     90   0.00  62.59  -2.22  -3.41   0.00   0.00   0.00  56.95
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 59.96 dBA

Total Leq All Segments: 59.96 dBA

♀
Results segment # 1: OLRT (night)
---------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !       31.30 !       14.44 !        14.44
       0.50 !       31.30 !       11.92 !        11.92

LOCOMOTIVE (0.00 + 33.70 + 0.00) = 33.70 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  39.33  -2.22  -3.41   0.00   0.00  -0.22  33.48*
     8     90   0.00  39.33  -2.22  -3.41   0.00   0.00   0.00  33.70
----------------------------------------------------------------------

 * Bright Zone !

WHEEL (0.00 + 33.71 + 0.00) = 33.71 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  39.34  -2.22  -3.41   0.00   0.00  -2.57  31.14*
     8     90   0.00  39.34  -2.22  -3.41   0.00   0.00   0.00  33.71
----------------------------------------------------------------------

 * Bright Zone !

Segment Leq : 36.72 dBA

Total Leq All Segments: 36.72 dBA

♀
Road data, segment # 1: Richmond (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
```

```
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  31.30 / 31.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  60.00 / 60.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.85 + 0.00) = 62.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
     8     90   0.00  68.48   0.00  -2.22  -3.41   0.00   0.00   0.00  62.85
----------------------------------------------------------------------------

Segment Leq : 62.85 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m
```

ROAD (0.00 + 56.31 + 0.00) = 56.31 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	65.75	0.00	-6.02	-3.41	0.00	0.00	0.00	56.31

Segment Leq : 56.31 dBA

Total Leq All Segments: 63.72 dBA

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 55.25 + 0.00) = 55.25 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	60.88	0.00	-2.22	-3.41	0.00	0.00	0.00	55.25

Segment Leq : 55.25 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 48.72 + 0.00) = 48.72 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	58.16	0.00	-6.02	-3.41	0.00	0.00	0.00	48.72

Segment Leq : 48.72 dBA

Total Leq All Segments: 56.12 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 65.25
(NIGHT): 56.17

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 36:54:26
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC25.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 2-5


Rail data, segment # 1: OLRT (day/night)
---------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            :   8.00 deg   Angle2 : 90.00 deg
Barrier height            :  10.00 m
Elevation                 :  10.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :  10.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !       13.90 !        9.57 !         9.57
       0.50 !       13.90 !        7.05 !         7.05

LOCOMOTIVE (0.00 + 51.68 + 0.00) = 51.68 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  62.58  -2.22  -3.41   0.00   0.00  -5.26  51.68
----------------------------------------------------------------------

WHEEL (0.00 + 47.22 + 0.00) = 47.22 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
     8     90   0.00  62.59  -2.22  -3.41   0.00   0.00  -9.73  47.22
```

Segment Leq : 53.01 dBA

Total Leq All Segments: 53.01 dBA

♀
Results segment # 1: OLRT (night)

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
4.00	13.90	9.57	9.57
0.50	13.90	7.05	7.05

LOCOMOTIVE (0.00 + 28.44 + 0.00) = 28.44 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	39.33	-2.22	-3.41	0.00	0.00	-5.26	28.44

WHEEL (0.00 + 23.98 + 0.00) = 23.98 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	39.34	-2.22	-3.41	0.00	0.00	-9.73	23.98

Segment Leq : 29.77 dBA

Total Leq All Segments: 29.77 dBA

♀
Road data, segment # 1: Richmond (day/night)

```
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

* Refers to calculated road volumes based on the following input:

```
    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00
```

Data for Segment # 1: Richmond (day/night)

```
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

♀
Road data, segment # 2: Byron (day/night)
```
----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00
```

Data for Segment # 2: Byron (day/night)
```
---------------------------------------
Angle1   Angle2           :   8.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  60.00 / 60.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

♀
Results segment # 1: Richmond (day)
```
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 62.85 + 0.00) = 62.85 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
     8     90   0.00  68.48   0.00  -2.22  -3.41   0.00   0.00   0.00  62.85
--------------------------------------------------------------------------

Segment Leq : 62.85 dBA
```

♀
Results segment # 2: Byron (day)
```
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 56.31 + 0.00) = 56.31 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
     8     90   0.00  65.75   0.00  -6.02  -3.41   0.00   0.00   0.00  56.31
--------------------------------------------------------------------------

Segment Leq : 56.31 dBA

Total Leq All Segments: 63.72 dBA
```

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 55.25 + 0.00) = 55.25 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	60.88	0.00	-2.22	-3.41	0.00	0.00	0.00	55.25

Segment Leq : 55.25 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 48.72 + 0.00) = 48.72 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
8	90	0.00	58.16	0.00	-6.02	-3.41	0.00	0.00	0.00	48.72

Segment Leq : 48.72 dBA

Total Leq All Segments: 56.12 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 64.07
(NIGHT): 56.13

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 37:26:12
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC31.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 3-1


Rail data, segment # 1: OLRT (day/night)
---------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2            : -90.00 deg   -41.00 deg
Wood depth                 :      0       (No woods.)
No of house rows           :      0 / 0
Surface                    :      2       (Reflective ground surface)
Receiver source distance   :  25.00 / 25.00  m
Receiver height            :   1.50 / 1.50   m
Topography                 :      4       (Elevated; with barrier)
No Whistle
Barrier angle1             : -90.00 deg   Angle2 : -41.00 deg
Barrier height             :  10.00 m
Elevation                  :  10.00 m
Barrier receiver distance  :  18.00 / 18.00  m
Source elevation           :   0.00 m
Receiver elevation         :  10.00 m
Barrier elevation          :   0.00 m
Reference angle            :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !        1.50 !        6.10 !         6.10
       0.50 !        1.50 !        3.58 !         3.58

LOCOMOTIVE (0.00 + 42.35 + 0.00) = 42.35 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -41   0.00  62.58  -2.22  -5.65   0.00   0.00 -12.36  42.35
----------------------------------------------------------------------

WHEEL (0.00 + 39.91 + 0.00) = 39.91 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -41   0.00  62.59  -2.22  -5.65   0.00   0.00 -14.81  39.91
```

Segment Leq : 44.31 dBA

Total Leq All Segments: 44.31 dBA

♀
Results segment # 1: OLRT (night)

Barrier height for grazing incidence

Source Height (m)	Receiver Height (m)	Barrier Height (m)	Elevation of Barrier Top (m)
4.00	1.50	6.10	6.10
0.50	1.50	3.58	3.58

LOCOMOTIVE (0.00 + 19.10 + 0.00) = 19.10 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	39.33	-2.22	-5.65	0.00	0.00	-12.36	19.10

WHEEL (0.00 + 16.66 + 0.00) = 16.66 dBA

Angle1	Angle2	Alpha	RefLeq	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	39.34	-2.22	-5.65	0.00	0.00	-14.81	16.66

Segment Leq : 21.06 dBA

Total Leq All Segments: 21.06 dBA

♀
Road data, segment # 1: Richmond (day/night)

```
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

* Refers to calculated road volumes based on the following input:

```
    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00
```

Data for Segment # 1: Richmond (day/night)

```
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  60.00 / 60.00  m
Receiver height           :   1.50 / 1.50   m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.61 + 0.00) = 60.61 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90    -41   0.00  68.48   0.00  -2.22  -5.65   0.00   0.00   0.00  60.61
----------------------------------------------------------------------------

Segment Leq : 60.61 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 54.08 + 0.00) = 54.08 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------------
   -90    -41   0.00  65.75   0.00  -6.02  -5.65   0.00   0.00   0.00  54.08
----------------------------------------------------------------------------

Segment Leq : 54.08 dBA

Total Leq All Segments: 61.48 dBA

♀
Results segment # 1: Richmond (night)
```

Source height = 1.50 m

ROAD (0.00 + 53.01 + 0.00) = 53.01 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	60.88	0.00	-2.22	-5.65	0.00	0.00	0.00	53.01

Segment Leq : 53.01 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 46.49 + 0.00) = 46.49 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	58.16	0.00	-6.02	-5.65	0.00	0.00	0.00	46.49

Segment Leq : 46.49 dBA

Total Leq All Segments: 53.88 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 61.56
(NIGHT): 53.89

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 37:29:21
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: rec311.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 3-11


Rail data, segment # 1: OLRT (day/night)
----------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:         ! Unadj. ! Annual % ! Years of !
 No  Name           ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT           ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2             : -90.00 deg   -41.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0 / 0
Surface                     :      2       (Reflective ground surface)
Receiver source distance    :  25.00 / 25.00  m
Receiver height             :  13.90 / 13.90  m
Topography                  :      4       (Elevated; with barrier)
No Whistle
Barrier angle1              : -90.00 deg   Angle2 : -41.00 deg
Barrier height              :  10.00 m
Elevation                   :  10.00 m
Barrier receiver distance   :  18.00 / 18.00  m
Source elevation            :   0.00 m
Receiver elevation          :  10.00 m
Barrier elevation           :   0.00 m
Reference angle             :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !       13.90 !        9.57 !          9.57
       0.50 !       13.90 !        7.05 !          7.05

LOCOMOTIVE (0.00 + 49.53 + 0.00) = 49.53 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -41   0.00  62.58  -2.22  -5.65   0.00   0.00  -5.18  49.53
----------------------------------------------------------------------

WHEEL (0.00 + 46.07 + 0.00) = 46.07 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
----------------------------------------------------------------------
   -90    -41   0.00  62.59  -2.22  -5.65   0.00   0.00  -8.65  46.07
```

```
---------------------------------------------------------------------

Segment Leq : 51.15 dBA

Total Leq All Segments: 51.15 dBA

♀
Results segment # 1: OLRT (night)
--------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !       13.90 !        9.57 !         9.57
       0.50 !       13.90 !        7.05 !         7.05

LOCOMOTIVE (0.00 + 26.29 + 0.00) = 26.29 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90    -41   0.00  39.33  -2.22  -5.65   0.00   0.00  -5.18  26.29
---------------------------------------------------------------------

WHEEL (0.00 + 22.83 + 0.00) = 22.83 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90    -41   0.00  39.34  -2.22  -5.65   0.00   0.00  -8.65  22.83
---------------------------------------------------------------------

Segment Leq : 27.91 dBA

Total Leq All Segments: 27.91 dBA

♀
Road data, segment # 1: Richmond (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

```
♀
Road data, segment # 2: Byron (day/night)
-----------------------------------------
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 2: Byron (day/night)
---------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  60.00 / 60.00  m
Receiver height           :  31.30 / 31.30  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

♀
Results segment # 1: Richmond (day)
-----------------------------------

Source height = 1.50 m

ROAD (0.00 + 60.61 + 0.00) = 60.61 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -41   0.00  68.48   0.00  -2.22  -5.65   0.00   0.00   0.00  60.61
--------------------------------------------------------------------------

Segment Leq : 60.61 dBA

♀
Results segment # 2: Byron (day)
--------------------------------

Source height = 1.50 m

ROAD (0.00 + 54.08 + 0.00) = 54.08 dBA
Angle1 Angle2  Alpha RefLeq  P.Adj  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
--------------------------------------------------------------------------
   -90    -41   0.00  65.75   0.00  -6.02  -5.65   0.00   0.00   0.00  54.08
--------------------------------------------------------------------------

Segment Leq : 54.08 dBA

Total Leq All Segments: 61.48 dBA

♀
Results segment # 1: Richmond (night)
```

Source height = 1.50 m

ROAD (0.00 + 53.01 + 0.00) = 53.01 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	60.88	0.00	-2.22	-5.65	0.00	0.00	0.00	53.01

Segment Leq : 53.01 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 46.49 + 0.00) = 46.49 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	58.16	0.00	-6.02	-5.65	0.00	0.00	0.00	46.49

Segment Leq : 46.49 dBA

Total Leq All Segments: 53.88 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 61.87
(NIGHT): 53.89

♀
♀

```
STAMSON 5.0        NORMAL REPORT       Date: 26-07-2017 37:27:12
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: REC35.te            Time Period: Day/Night 16/8 hours
Description: Reception Point 3-5


Rail data, segment # 1: OLRT (day/night)
----------------------------------------
Train            ! Trains      ! Speed !# loc !# Cars! Eng  !Cont
Type             !             !(km/h) !/Train!/Train! type !weld
-----------------+-------------+-------+------+------+------+----
* 1. OLRT        ! 422.0/1.0   !  65.0 !  1.0 !  1.0 !  Elec! Yes

* The identified number of trains have been adjusted for
  future growth using the following parameters:

Train type:          ! Unadj. ! Annual % ! Years of !
 No  Name            ! Trains ! Increase !  Growth  !
--------------------+--------+----------+----------+
  1. OLRT            ! 422.0/1.0   !    0.00  !    0.00  !

Data for Segment # 1: OLRT (day/night)
--------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      4       (Elevated; with barrier)
No Whistle
Barrier angle1            : -90.00 deg   Angle2 : -41.00 deg
Barrier height            :  10.00 m
Elevation                 :  10.00 m
Barrier receiver distance :  18.00 / 18.00  m
Source elevation          :   0.00 m
Receiver elevation        :  10.00 m
Barrier elevation         :   0.00 m
Reference angle           :   0.00

♀
Results segment # 1: OLRT (day)
-------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+---------------
       4.00 !       13.90 !        9.57 !         9.57
       0.50 !       13.90 !        7.05 !         7.05

LOCOMOTIVE (0.00 + 49.53 + 0.00) = 49.53 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90    -41   0.00  62.58  -2.22  -5.65   0.00   0.00  -5.18  49.53
---------------------------------------------------------------------

WHEEL (0.00 + 46.07 + 0.00) = 46.07 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
---------------------------------------------------------------------
   -90    -41   0.00  62.59  -2.22  -5.65   0.00   0.00  -8.65  46.07
```

```
-----------------------------------------------------------------------

Segment Leq : 51.15 dBA

Total Leq All Segments: 51.15 dBA

♀
Results segment # 1: OLRT (night)
---------------------------------

Barrier height for grazing incidence
------------------------------------
Source      ! Receiver    ! Barrier     ! Elevation of
Height  (m) ! Height  (m) ! Height  (m) ! Barrier Top  (m)
------------+-------------+-------------+--------------
       4.00 !       13.90 !        9.57 !         9.57
       0.50 !       13.90 !        7.05 !         7.05

LOCOMOTIVE (0.00 + 26.29 + 0.00) = 26.29 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90    -41   0.00  39.33  -2.22  -5.65   0.00   0.00  -5.18  26.29
-----------------------------------------------------------------------

WHEEL (0.00 + 22.83 + 0.00) = 22.83 dBA
Angle1 Angle2  Alpha RefLeq  D.Adj  F.Adj  W.Adj  H.Adj  B.Adj SubLeq
-----------------------------------------------------------------------
   -90    -41   0.00  39.34  -2.22  -5.65   0.00   0.00  -8.65  22.83
-----------------------------------------------------------------------

Segment Leq : 27.91 dBA

Total Leq All Segments: 27.91 dBA

♀
Road data, segment # 1: Richmond (day/night)
--------------------------------------------
Car traffic volume  : 12144/1056  veh/TimePeriod  *
Medium truck volume :   966/84    veh/TimePeriod  *
Heavy truck volume  :   690/60    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)

* Refers to calculated road volumes based on the following input:

    24 hr Traffic Volume (AADT or SADT):  15000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00

Data for Segment # 1: Richmond (day/night)
------------------------------------------
Angle1   Angle2           : -90.00 deg   -41.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0 / 0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  25.00 / 25.00  m
Receiver height           :  13.90 / 13.90  m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00
```

♀
Road data, segment # 2: Byron (day/night)

```
Car traffic volume  :  6477/563   veh/TimePeriod  *
Medium truck volume :   515/45    veh/TimePeriod  *
Heavy truck volume  :   368/32    veh/TimePeriod  *
Posted speed limit  :    50 km/h
Road gradient       :     0 %
Road pavement       :     1 (Typical asphalt or concrete)
```

* Refers to calculated road volumes based on the following input:

```
    24 hr Traffic Volume (AADT or SADT):   8000
    Percentage of Annual Growth        :   0.00
    Number of Years of Growth          :   0.00
    Medium Truck % of Total Volume     :   7.00
    Heavy Truck  % of Total Volume     :   5.00
    Day (16 hrs) % of Total Volume     :  92.00
```

Data for Segment # 2: Byron (day/night)

```
Angle1   Angle2             : -90.00 deg   -41.00 deg
Wood depth                  :      0       (No woods.)
No of house rows            :      0 / 0
Surface                     :      2       (Reflective ground surface)
Receiver source distance    :  60.00 / 60.00  m
Receiver height             :  13.90 / 13.90  m
Topography                  :      1       (Flat/gentle slope; no barrier)
Reference angle             :   0.00
```

♀
Results segment # 1: Richmond (day)

Source height = 1.50 m

ROAD (0.00 + 60.61 + 0.00) = 60.61 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	68.48	0.00	-2.22	-5.65	0.00	0.00	0.00	60.61

Segment Leq : 60.61 dBA

♀
Results segment # 2: Byron (day)

Source height = 1.50 m

ROAD (0.00 + 54.08 + 0.00) = 54.08 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	65.75	0.00	-6.02	-5.65	0.00	0.00	0.00	54.08

Segment Leq : 54.08 dBA

Total Leq All Segments: 61.48 dBA

♀
Results segment # 1: Richmond (night)

Source height = 1.50 m

ROAD (0.00 + 53.01 + 0.00) = 53.01 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	60.88	0.00	-2.22	-5.65	0.00	0.00	0.00	53.01

Segment Leq : 53.01 dBA

♀
Results segment # 2: Byron (night)

Source height = 1.50 m

ROAD (0.00 + 46.49 + 0.00) = 46.49 dBA

Angle1	Angle2	Alpha	RefLeq	P.Adj	D.Adj	F.Adj	W.Adj	H.Adj	B.Adj	SubLeq
-90	-41	0.00	58.16	0.00	-6.02	-5.65	0.00	0.00	0.00	46.49

Segment Leq : 46.49 dBA

Total Leq All Segments: 53.88 dBA

♀

TOTAL Leq FROM ALL SOURCES (DAY): 61.87
(NIGHT): 53.89

♀
♀

APPENDIX 3

CORRESPONDENCE

Stephanie Boisvenue

From: Schmidt, Mike <Mike.Schmidt@ottawa.ca>
Sent: July-24-17 9:55 AM
To: Stephanie Boisvenue
Subject: RE: Proximity Study - 851 Richmond Road
Attachments: 2017_07_20__CIV-0123-CK-CW_profile__851_Richmond_Rd.dwg; 2017_07_20__TRK-0-CK-CW_Align__851_Richmond_Rd.dwg; TRK-2-CK-SHEETS.PDF; TUN-2-S-115to195.pdf; TUN-2-S-115to195 Section.pdf

Hi Stephanie,

Attached is the track horizontal alignment and vertical profile between New Orchard Station and Cleary Station. This shows where the centerline of tracks will physically be located within the Byron Linear Park. In addition, you can see the depth of the track relative to OG (original grade). Furthermore, you may go to GeoOttawa to see the entire Stage 2 LRT alignment by selecting Rail Implementation Office layer http://maps.ottawa.ca/geoottawa/. Attached are (CAD) Alignment files for confederation line limited to the area adjacent to the development. These are stripped down horizontal and vertical alignment but will provide info needed. Attached is also a cross-section showing the typical tunnel box within the Byron Park as well as the Tunnel Alignment.

In terms of the information requested information for the noise and vibration study the following information has been provided to me by our team:

These values are for 2024 (opening year of Confed West):

- On a typical weekday, 244 trips in each direction (488 total)
- Trains are two cars long (2 x 49m = 98 m) and are electric-powered (no locomotives)
- Speeds alongside this parcel range from 45-60 kph. (Speeds in the Cleary Station area are limited to 45kph, though it’s difficult to say exactly what the passing speed will be.)

As previously mentioned the track alignment and station locations cannot be considered finalized until the contract is awarded and final design completed.

Regards,

Mike

Mike Schmidt
Planner II | Urbaniste II
O-Train Planning | Planification de l'O-Train
Transportation Services Department | Direction générale des transports
City of Ottawa | Ville d'Ottawa
613-580-2424 x 13431

From: Schmidt, Mike
Sent: Thursday, July 20, 2017 12:31 PM
To: Stephanie Boisvenue <SBoisvenue@Patersongroup.ca>
Subject: RE: Proximity Study - 851 Richmond Road

APPENDIX 4

Proximity Assessment:

Report PG4202-LET.01 Revision 1 dated October 11, 2017

patersongroup

Consulting Engineers

154 Colonnade Road South
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Hydrogeology
Geological Engineering
Materials Testing
Building Science
Archaeological Services

www.patersongroup.ca

October 11, 2017
Report: PG4202-LET.01 Revision 1

Homestead Land Holdings
80 Johnson Street
Kingston, Ontario
K7L 1X7

Attention: **Mr. David Trousdale**

Subject: **Proximity Assessment**
Proposed Residential Building
851 Richmond Road - Ottawa

Dear Sir,

Further to your request and authorization, Paterson Group (Paterson) prepared the current letter report to summarize any construction issues, which could occur due to the proximity the proposed building with respect to the subject alignment of the proposed Confederation Line Light Rail project. The following letter should be read in conjunction with Paterson Report PG4163-1 dated October 3, 2017.

1.0 Background Information

The proposed development at 851 Richmond Road will consist of an 11 storey building placed greater than 3 m away from the property boundary along Richmond Road. At the time of issuance of this report, the final alignment of the Confederation Line has not been determined. However, it is understood that the subject alignment will be located either within the Richmond Road right-of-way or Byron Avenue right-of-way. Based on discussions with the City of Ottawa, it is understood that the alignment will most likely be placed below Byron Avenue. However, as there is a possibility of the proposed Confederation Line being placed below Richmond Road, the City of Ottawa has requested that this alignment be used for the proximity study.

The following sections summarize our existing soils information and construction precautions for the proposed building, which may impact the subject alignment of the Confederation Line.

2.0 Subsurface Conditions

Based on existing geotechnical information, the subsurface conditions in the immediate area of the subject site and subject Confederation Line alignment consist of the following:

❏ Existing surface grade is at an elevation of approximately 65.5 to 66 m.
❏ The overburden thickness is approximately 2 to 4.6 m.
❏ Bedrock surface elevation is at approximately 61.5 to 63.7 m.
❏ The bedrock underlying the site consists of a good quality limestone bedrock. Unconfined compressive strengths of similar limestone bedrock formations, where tested, typically exceed 80 MPa.

Tunnel Location

Preliminary drawings indicate that an approximate setback of 2.3 m is present between the property line and the proposed Confederation Line. Additionally, it is understood that the proposed building will be offset 3.2 m from the property line. Therefore, a horizontal separation of 5.5 m is present between the subject alignment of the Confederation Line and the proposed building at 851 Richmond Road. Based on preliminary design drawings, the underside of tunnel elevation will be at an elevation ranging from 52.5 to 55 m along the subject alignment. The founding elevation of the proposed building will be approximately 57 m (geodetic). Therefore, a vertical differential of between 2 and 4.5 m is present between founding levels of the two structures with a horizontal separation of at least 6.5 m.

3.0 Construction Precautions and Recommendations

Influence of Proposed Development on Tunnel

Based on existing soils information and building design details, the footings of the proposed building will be founded on good quality bedrock. Therefore, lateral loads due to the building footings will be transferred directly into the bedrock well within a conservative 1H:6V zone of influence from the outside face of footing. Based on the preliminary information provided for the subject alignment and the proposed building location, the proposed building at 851 Richmond Road will not cause additional loading on the subject alignment of the Confederation Line.

It is understood that the Confederation Line will be constructed following the construction of the proposed building at 851 Richmond Road, and therefore the construction of the proposed building at 851 Richmond Road will not negatively impact the construction of the subject alignment of the proposed Confederation Line.

Excavation and Temporary Shoring

The overburden along the perimeter of the proposed building footprint will need to be temporarily shored with solder pile and lagging and/or interlocking sheet piles in order to complete the construction of the underground parking structure for the proposed building. Bedrock removal is also anticipated, which will be completed by line drilling, blasting and/or hoe ramming. The blasting and hoe ramming will be carried out by a contractor specializing in bedrock removal. It is understood that the bedrock removal for the proposed building will be completed prior to the construction of the subject alignment of the proposed Confederation Line. Therefore, there will be no impact of the building excavation on the subject alignment of the proposed Confederation Line.

It should be noted that the temporary shoring system will be designed for at-rest earth pressures, using a pressure coefficient of K_0=0.5 as per geotechnical design recommendations outlined in Paterson Report PG4163-1 dated July 26, 2017.

If the bedrock removal for the proposed building is to be completed after the subject alignment of the Confederation Line has been completed, a seismograph is to be installed either adjacent to or within the Confederation Line to monitor vibrations during the bedrock removal program. A program detailing trigger levels and action levels will be detailed by Paterson, if the building construction is to be completed after construction of the subject alignment of the Confederation Line.

Pre-Construction Survey

It is understood that the proposed building at 851 Richmond Road will be constructed prior to the construction of the Confederation Line. Therefore, a pre-construction survey of the tunnel structure will not be possible at the time of construction of the subject building. Any existing structures in the immediate area of the proposed building will undergo a pre-construction survey as per standard construction practices, where bedrock blasting will be required.

Groundwater Control

Groundwater observations during the geotechnical investigation indicated groundwater levels between 2 to 4 m below the existing ground surface. However, the Confederation Line is to be founded at an elevation lower than the proposed development. Therefore, no groundwater lowering effects due to the proposed development are anticipated with respect to the Confederation Line.

Tunnel Waterproofing System

The proposed building will be constructed prior to the construction of the subject alignment of Confederation Line. Therefore, the construction of the proposed building will not negatively impact the waterproof finish of the tunnel structure. Also, due to the separation between the proposed building at 851 Richmond Road and the subject alignment of Confederation line, it is anticipated that the replacement or repair of the waterproofing system for the tunnel structure will not be required during construction.

4.0 Conclusions and Recommendations

Based on the currently available information for the subject alignment of the proposed builidng and the existing soils information, the proposed building does not negatively impact the proposed tunnel alignment.

We trust that this information satisfies your immediate request.

Best Regards,

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
October 11-2017
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Stephanie A. Boisvenue, P.Eng.

David J. Gilbert, P.Eng.